Shrinkage of Earthwork.*

BY P. J. FLYNN, M. TECH. SOC.

(Concluded from page 279.)

In the practice of American and English engineers there is considerable divergence amongst themselves as to the *subsidence* or settlement of embankments, which *subsidence* again depends on their shrinkage in volume. Some authors give the percentage of shrinkage without any reference to settlement of bank, and in these cases the inference to be drawn is that the settlement is the same as the shrinkage. Other authors give rules for the settlement which do not agree with the shrinkage.

In order to show the want of accord in the rules given, I give three examples from three well known authors. Searles, in his *Field Engineering*, gives the ratio of shrinkage to cut for different materials, and adds with reference to settlement:

"The lineal *settlement* will be about in the ratios given above."

An investigation will show this rule to be correct.

Alexander L. Holley, C. E., in his *Railway Practice*, states:

"The shrinkage of earthwork is stated to be as the cube of the depth; hence the necessity of due provision in lofty banks."

For the purpose of illustration, the shrinkage and settlement are assumed for a bank 5 feet high, and from this the settlement of a bank 40 feet high is found. The bank shown in Fig 1 (not to scale) is 14 feet wide on top, 5 feet deep, and has side slopes 1½ to 1.

FIG. 1.

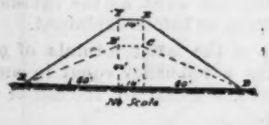
After ultimate shrinkage the 5 foot bank is assumed to have settled 3 inches; therefore the area of shrinkage will be *a, b, c, d, e, f, a*, on fig. 1.; equal to $21.5 \times .25 = 5.375$ square feet, which is a reasonable shrinkage, being only 5 per cent. of the area of the bank.

Now as $40^3 : 5^3 :: 512 : 1$.

Therefore the shrinkage of the 40 feet bank will be:

$5.375 \times 512 = 2752$ square feet. This is equal to *A, B, C, D, E, F, A*, Fig. 2; and as the shrinkage is all vertical, the area of shrinkage divided by mean width = settlement.

FIG. 2.



Therefore the settlement $= \frac{2752}{74} = 37$ feet,

being almost the full height of bank.

If the shrinkage of the 5 feet bank be taken at only 2 per cent., then, by the rule of the cube of the depth the settlement of the 40 feet bank will be 14 feet. From these examples it will be seen that this rule does not hold good, and that the shrinkage is not as the cube of the depth. Mr. Holley evidently copied this rule without investigation.

There is a sort of scientific look about the rule, but an investigation will show that it is nothing more than a most useless and misleading "rule of thumb."

To show how rules are sometimes glanced over and accepted without investigation, it may be mentioned that this rule was given, several years since, in a work which, in other respects, is accurate, namely, the Treatise on Civil Engineering in use at the Roorkee Civil Engineering College, and, in all likelihood, it is continued in it to the present day in the last edition. It was not until long after the writer left the college that he tested its accuracy and found out its fallacy.

Vose, in his *Manual for Railroad Engineers*, quotes the experiments of Morris for shrinkage, after which, and under the heading of *subsidence*, he states:

"It has in some cases been specified that the embankments, when completed by the contractor, should be finished to the full height from 3 inches above the intended height, upon a bank 5 feet high, to 9 inches upon a 40-foot bank; and intermediate heights in proportion."

Vose here gives a rule that in a certain case, when a 5 feet bank subsides 3 inches a 40 feet bank will subside 9 inches. He also states that banks shrink a certain percentage *in proportion to their volume*. As already shown, the shrinkage of a 5-foot bank, and corresponding to a subsidence of 3 inches, is 5.375 square feet, which is five per cent. of the area of bank 107.5 square feet.

Now, a 40-foot bank (Fig. 2) has an area of 2960 square feet, and five per cent. of this = 148 square feet = its shrinkage; and as this shrinkage occurs only in the vertical direction, $\frac{148}{74} = 2$ feet = the depth of settlement, and not 9 inches. From this it will be seen that the rules for shrinkage and settlement, as given by Vose, do not agree with each other.

I think I have shown that there is a great want of general ageement in the results of experiments on shrinkage, and also in the rules for settlement as given by writers on the subject.

Holley says: "Correct allowance is made for the settling of the material of the bank, and time is given for this settling to occur before the ballast is brought on, or the rails and sleepers laid. The shrinkage of earthwork sometimes disturbs the grade at a rate of several feet rise or fall per mile—in normal grades of 60 feet, on the New York and Erie road, a distance of 500 feet was found to rise at the rate of 75.4 feet per mile, this distance being approached and succeeded by the regular grade of 60 feet. In another place, for the distance of 200 feet, the rise was found to be at the rate of 116.7 per mile, with a level of 100 feet length both above and below—the average grade over the whole mile being 60 feet. These cases are similar to what occurs where railway earthwork is not properly settled before being brought into use."

On the assumption that the settlement is in proportion to the shrinkage in volume, I will now show that even when due allowance for settlement is given to the bank to make up for the shrinkage in volume *from cut to fill*, still cases happen where the bank will settle more than that allowance, and it is possible that the banks mentioned by Mr. Holley had, when they were first built, the full allowance for settlement usually given.

It is well to note here that there is a marked difference, in some cases, between the shrinkage of an *embankment*, and the shrinkage of the material of which it is composed, *from cut to fill*.

Trautwine says: "Although earth, when first dug, and loosely thrown out, *swells* about ⅛ part, so that a cubic yard *in place* averages about 1¼ or 1.2 cubic yards when dug; or 1 cubic yard dug is equal to ⅘, or to .8333 of a cubic yard in place; yet when made into an embankment it gradually subsides, settles or shrinks into a less bulk than it occupied *before being dug*."

Molesworth, in his Pocket Book, states that clay, before subsidence, increases in volume twenty per cent. from cut to fill, but that after subsidence it shrinks in bank eight per cent. less than the volume in cut. The *embankment* therefore shrinks from a volume of 120 to a volume of 92. This amounts to a *total shrinkage of embankment* of twenty-three per cent.

Mr. Specht's experiments support these statements as to the first or temporary increase from cut to fill. He found that "53,350 cubic yards in cut gave 58,350 in fill," in "sandy loam with small amounts of adobe and hard pan," which is an increase of 9.4 per cent. Mr. Specht remarks with reference to this increase: "This question must not be confounded with that of final settlement, which sometimes even continues for a long time after the embankment is finished."

The temporary increase of volume in embankment mentioned below, has reference to banks built up with some rapidity, to full height and without layers.

In the table, page 278, it will be seen that, for materials similar to Mr. Specht's embankment, American and English engineers give a permanent shrinkage from cut to fill of from 8 to 12.5 per cent., being an average about ten per cent.

This final shrinkage, as well as the first increase, being allowed it is evident that the *total shrinkage of an embankment from its first completion* to its *permanent settlement* must equal the *first increase* in bank beyond the volume in cut, plus the *final shrinkage* from cut to fill, that is, in the case just given, $9.4 + 10 = 19.4$ in a volume of 110 which is equivalent to 17.6 per cent.

In order to have a permanent depth of 40 feet after settlement, an embankment in the material just described would require to be built 48.5 feet in depth at first.

If the banks mentioned by Mr. Holley were intended to be, say as an instance, 46 feet high after final settlement, and that the material of which they were constructed increased at first 5 per cent. more than cut, and had a final shrinkage of 10 per cent. less than the cut than the total shrinkage of 14 per cent., would require the depth at first to be 53.5 feet. If however, 10 per cent. be allowed only for shrinkage, the bank will at first be 51.1 feet deep, and as the actual settlement of this at 14 per cent. will be 7.2 feet, the bank at final settlement of this at 14 per cent. will be 7.2 feet, the bank at final settlement will be only 43.9 feet deep instead of 46 feet, which is 2.1 feet lower than intended. This is as much as the greatest settlement of bank already mentioned by Mr. Holley, and is due entirely to the fact that no increase in depth of bank was allowed in proportion to the first increase in volume from cut to fill.

Is it not probable that a great deal of the settlement noticed in earthern banks is to be accounted for as just explained?

For *balancing* cuts and fills, only the permanent difference of volume in cut and settled bank is to be taken into account, but for settlement of bank an additional allowance has to be made for the temporary increase in volume from cut to fill.

Cases occur where it would not be advisable to allow for the full shrinkage of a bank during construction, and it is here that the element of *time* is of importance. Hewson, in his work on *Levees*, says:

"Sand, however loosely it may be shoveled together, fills its space closely; and, therefore, whether wet or dry, settles at a very small diminution of the original bulk. In time too, the process of this settlement is short."

Spons' Dictionary of Engineering states:

*Transactions of the Technical Society of the Pacific Coast. Read June 5, 1886.

"The ultimate settlement of embankments of gravel or chalk does not require more than two or three years, but clay embankments may in some cases, continue to shrink for ten years."

To give an instance where it would not be advisable to allow for the full shrinkage. Let an embankment, on a maximum or ruling grade of 1 in 100, be built across a hollow, and let its depth gradually increase until at a distance of 200 feet from beginning of fill, its depth is 40 feet. From experience with similar material, it is known that the embankment will shrink about 10 per cent. within two years, of which five per cent. takes place within six months, and another five per cent. within a further period of 18 months. The road is to be in full operation within about six months from construction of the embankment. Now, if an allowance is made in height of bank for ultimate shrinkage of 10 per cent., then its height at greatest depth will be 44.4 feet, but as, within six months, it will shrink only 5 per cent., then its height at that time will be 42.2 feet—that is 2.2 feet higher than grade. This 2.2 feet additional height is gained in 200 feet, and it increases the grade of road, from 1 in 100 to a steeper grade than 1 in 50, but as the ruling grade is to be 1 in 100, the allowance for ultimate settlement during the construction of the bank is not admissable. If, however, shrinkage of only 5 per cent. be allowed at first, and the bank built up to 42.1 feet in height, it will, at the end of six months have settled down to 40 feet, and be even with the ruling grade. After this, as the bank gradually settles, it can in the regular course of track repairs be brought to grade by the trackmen with additional ballast.

As to the effect of *time* in the consolidation of banks, the writer is of opinion that an embankment, built of loam with a slight admixture of sand, does not after several years so shrink and consolidate as to be equal for hydraulic work to a comparatively new bank built in layers of less than one foot thick and rammed. The effect of time does not consolidate the bank so much as punning during construction. This opinion is based upon considerable experience in cutting through banks of the material mentioned.

Very old banks are not here referred to, as the writer has had no experience with them.

In the original construction of that part of the Grand Trunk Road from Lahore to Wuzeerabad, in the Punjab, provision was made for drainage—by bridges and culverts—only at the well-defined drainage channels. After the completion of the embankments, the drainage works were found insufficient to carry off the flood waters, as before the construction of the embankment, more water was passed away over the surface of the country than by the well defined drainage channels. In times of very heavy rainfall the embankment dammed back this water, which rose behind it, flooded the country on the up-stream side of the bank, breached the road, carried away bridges and impeded the traffic.

In the construction of bridges and *metaled gaps* to carry off the flood waters, the writer had to cut through the embankments in more than twenty-four places, making an aggregate length of more than 8,000 feet in a distance of fifty-eight miles.

In places where the bank was built without punning, it was found, that after taking off about two feet in depth of the top, the body of the bank appeared like material newly deposited, and it was easily excavated. On the other hand, the banks which were built in layers and punned, were found to be well consolidated and much more difficult to excavate. The difference in the banks, though built of the same material was very marked, the punned banks, even when comparatively new, being much more difficult to excavate than the others.

After each rainy season the tops and slopes of the unpunned banks were much more cut up and fissured, and required more repairs than those that were punned.

The banks were 40 feet wide on top, with side slopes of 2 to 1 and from 4 to 12 feet high.

In some cases, during floods, the unpunned banks were breached by leakage, before the water reached their tops, but not in a single instance was the punned bank breached by leakage. When, however, the punned banks were breached, the water first rose above their tops, and in flowing over them and falling to the down stream level, cut through them.

After a bank was constructed, the heavy and continuous traffic passing over it so consolidated its top that it acted as a roof, and passed off the rain-water to the side slopes. The rain-water was thus prevented from entering the body of the bank and contributing to its shrinkage.

From the experience gained in this work, it is the opinion of the writer that time does not so compact and solidify an old, unrammed bank as to make it equal for the purpose or impounding water to a rammed bank, even when the latter has been built more recently; and it is also his opinion that the top of a bank for impounding water should not be used as a roadway until after the lapse of sufficient time to allow it to take its ultimate shrinkage.

A few words here in explanation of metaled gaps. They are simple, inexpensive roadworks, to pass off surface flood waters, and to save bridging.

It was found that the bridging on the Grand Trunk Road required to pass off the flood water, amounted to more than 8,000 feet in length. The great expense and the length of time required to complete this work prohibited bridging. To provide ample outlets for surface drainage, portions of the embankment varying in length, according to the requirements, of the flood waters, from 100 to 1,700 feet at ground level, were excavated, and from ground level at each end slopes of one in thirty were made to top of bank. The slopes and the portion on level of country were metaled to a width of 18 feet, and on each side of the metal, a brick wall, 2 feet deep and 1 foot wide, was built, the top of the walls being on a level with the metaling. A row of guide-posts 100 feet apart were fixed on each side of the metaling to guide travelers and vehicles to keep on the roadway during floods. During floods, which continue for only a few days in the year, these gaps passed off the surface flood-water at a low depth—less than two feet—and at such a low velocity as to permit traffic to be carried on in safety through the water, though at great trouble and inconvenience.

During floods the gaps were fords, and at other times they made a good metaled road.

After the flood subsided, the ordinary drainage of the country was passed off by the well-defined and deep channels which had bridges or culverts built over them.

This cheap expedient of gaps for passing off surface flood-water permitted the opening of the road, during the rainy season, several years before it would otherwise have been done, had bridges been built at the time, instead of gaps, for carrying off all the surface flood-water.

I will now show that under certain forms of longitudinal section, and one very likely to occur in broken ground, the use of certain formulæ in the computation is sure to cause a serious error in the result. Gillespie says in his *Roads and Railroads*:

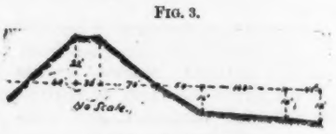
"Average end areas is the most usual method in this country" for computing earthworks.

Morris, in his *Earthworks*, says in reference to the same formula:

"This rule has been by far the most used of any in our country. With tables of cubic yards it is very expeditious, and has found numerous advocates among engineers on account of its simplicity and convenience."

Searles states that this formula is approved by statute to be used in the public works of the State of New York.

FIG. 3.



LONGITUDINAL SECTION.

The diagram represents the longitudinal section of part of a line of railroad, the ground at all points transversely to the entire line being level, so that all cross-sections will be on level ground.

The cut is 18 feet wide at base, with side slopes 1 to 1, and the fill 14 feet on top, with side slopes 1½ to 1.

In order to make an experiment on shrinkage, the engineer takes out the cut and builds the bank to the sections required. The end of the bank is assumed to stand vertically at A. The quantity in cut completes the embankment for 197.06 feet in length as shown in diagram. After final measurement, the engineer computes his quantities by the formula of average end areas. He finds the volume of cut = 3,096 cubic yards, and the fill = 2,784 cubic yards. The quantity in cut appears, therefore, to exceed the fill by 312 cubic yards, showing a shrinkage of ten per cent. In fact, however, there is no shrinkage. If the computations are made by the *prismoidal formula*, the volume of the cut will be found to be equal to that of the fill, 2708 cubic yards, so that the apparent shrinkage of ten per cent. was entirely due to the use of an incorrect formula.

If, again, the computation be made by the formula of *average end heights*, in which a section is taken with a height equal to the average of the two end heights, the volume of the cut will be = 2514 cubic yards, and the fill = 2 670 cubic yards, showing an increase of 156 cubic yards = six per cent., which increase does not exist, as the cut and fill exactly balance, as before explained.

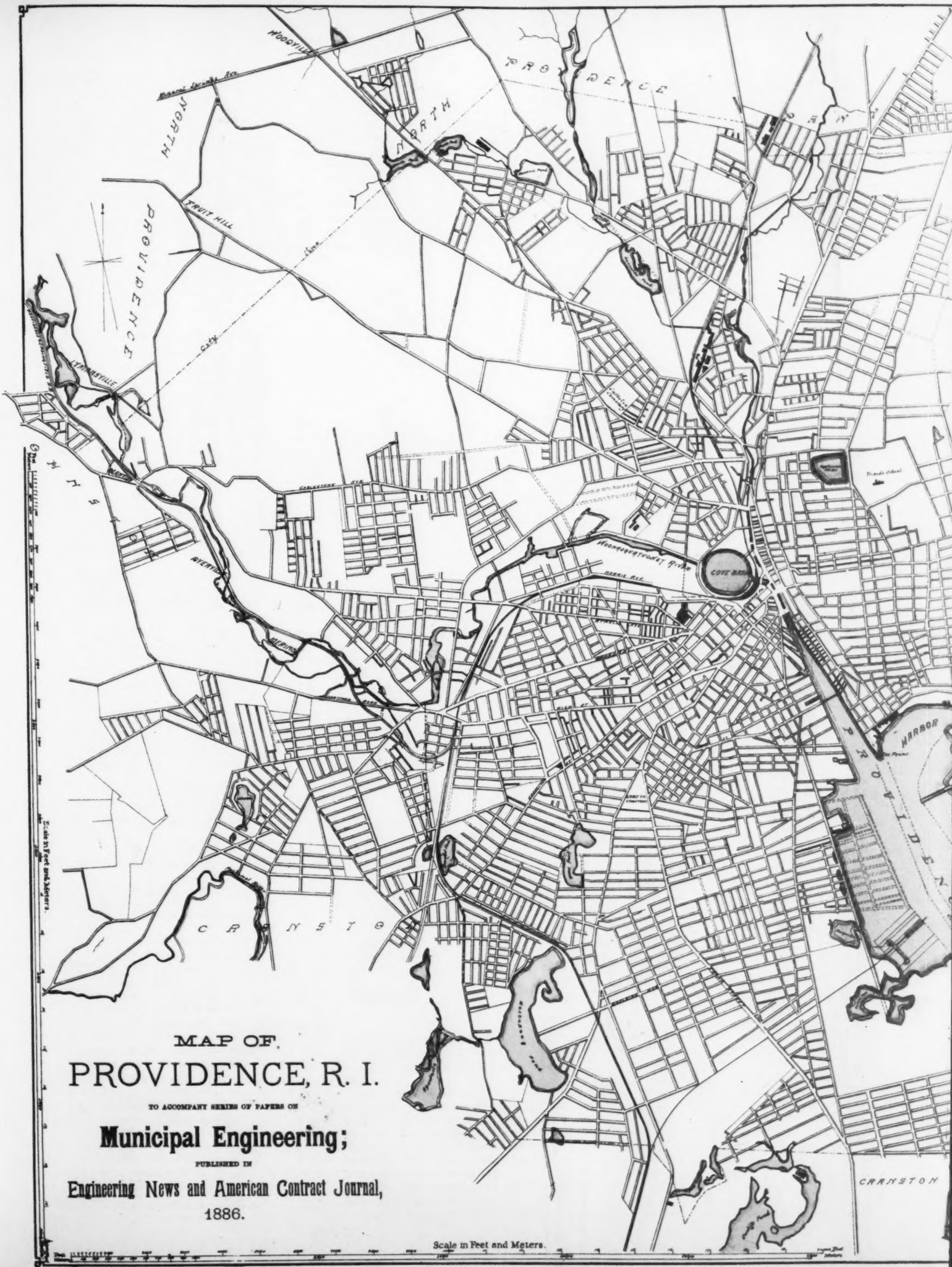
The use of the latter formula of mid sections gives a deficiency equal in amount to half the excess found by the use of average end areas.

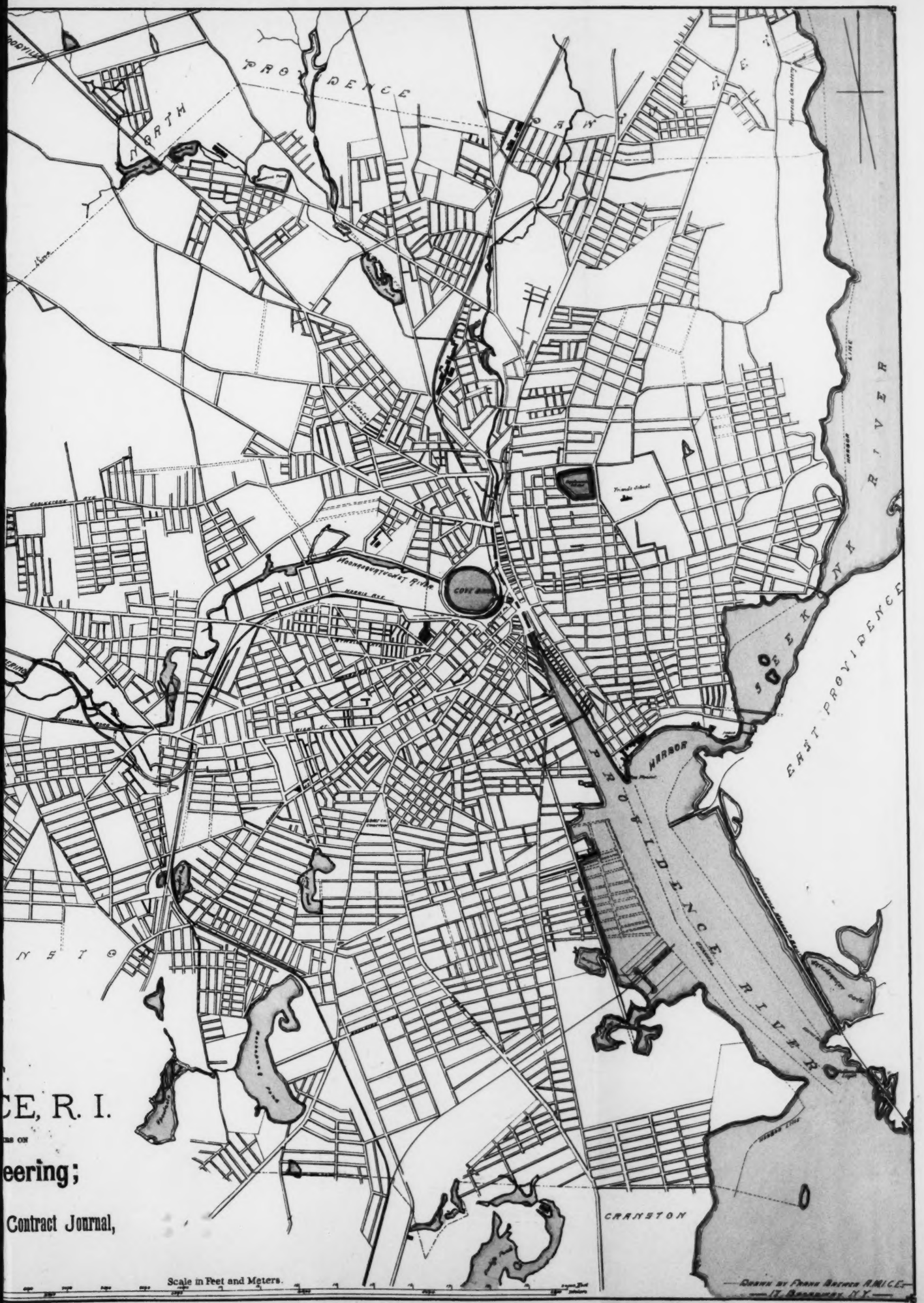
Another formula by *mean proportionals* which gives less than the correct result, is sometimes used. The prismoidal formula is the only one of the four given which is sure to give correct results.

The error will be even more than shown above, when the ground at cut slopes also across the center line of road.

The error is greatest when one of the end areas = O, as seen in the column of cut given below. In similar cross-sections, in ground where the end heights do not materially differ, the error is small, as will be seen in column of fill given below. Error in the results, however, can be avoided only in so far as the computations are concerned by the use of the prismoidal formula.

The following table gives the volume of cut and fill by the three formulæ used above:


MAP OF
PROVIDENCE, R. I.
TO ACCOMPANY SERIES OF PAPERS ON
Municipal Engineering;
PUBLISHED IN
Engineering News and American Contract Journal,
1886.
Scale in Feet and Meters.
NORTH PROVIDENCE
PROVIDENCE
CRANSTON
HARBOR
COVE BASIN
FRUIT HILL
LYMANSVILLE
WEBBING
Woonasquatucket River



CE, R. I.

eering;

Contract Journal,

	Cut Cu. Yrds.	Fill Cu. Yrds.
Prismoidal formula...	2,708	2,708
Average end area.....	3,096	2,784
Average end heights..	2,514	2,670

There is a tendency among workmen to leave the side slopes curved in cross section. For instance, embankments are sometimes finished with the side slopes concave, as shown in Fig. 4: and cuttings, especially in hard ground, are left with the side slopes convex, as show in Fig. 5:

FIG. 4.

It is therefore advisable, in cross-sectioning the work for final measurement, to take levels and measurements at frequent intervals, and before doing this work the adjustment of the level and the length of measuring instruments, chain tape, etc., should be looked to.

FIG. 5.

In descriptions of *shrinkage* experiments on earthwork, the following information would be useful, and in addition such other information as might be deemed of use in arriving at a correct result:

1. The description of material and locality.
2. Method of construction, such as by scrapers, wheelbarrows, tipping from wagons, etc.
3. Longitudinal section, and also cross-sections of cutting and embankment.
4. Average depth of layers, and if rammed.
5. Foundation of bank, that is, description of ground on which the embankment is constructed.
6. Dates of commencement and completion of bank and of measurement.
7. Rainfall, if any, and a general description of weather during period of work.
8. The formula used in computing the quantities.
9. If base of bank has been flooded, the depth of flooding, period during which flood lasted, and state of bank at the time should be given.

Municipal Engineering; Paper No. 2.*

PROVIDENCE, RHODE ISLAND.

(*Continued from Page 259*).

Sewerage.

The Sewerage system adopted by this city is the Combined System, the first sewer of which was built in 1871. The length of sewers constructed up to the first of January, 1886, is 53.046 miles), of which 36.309 miles (or 68 per cent.) are pipe sewers and 16.737 miles (or 32 per cent.) are brick sewers.

All sizes under twenty-four inches in diameter are built circular, above twenty-four inches in diameter the oval shape is almost wholly used. Two forms of oval sewer (see Plate 14) have been extensively used. The great majority of brick sewers now built are of the egg shape.

Vitrified pipe has been used for the 12, 15 and a small amount of 18-inch sewer; single course brick for sewers 16, 18, 20, 22 and some 24-inches in diameter, and double course brick for all sizes larger than twenty-four inches in diameter or its equivalent size 20 by 30-inch oval. From 1871 to 1875 Scotch pipe was used almost exclusively; since the latter date pipe of American make has been used, principally Akron, Rader and Rochester makes, which have been inspected and accepted in accordance with the following specification:

"The twelve and fifteen-inch pipes are to be in lengths of three feet, and all pipe are to be made of good clay, salt glazed, uniform in texture and thoroughly burned. Eighty per cent. of the quantity to be less than one-fourth inch out of round and less than three-eighths inch out of straight. No pipe is to exceed one-half of an inch out of straight or out of round, and in no case is any pipe to be out of round on different diameters at different ends. The glazing and the thickness of pipes to be satisfactory. All material furnished shall be subject to inspection and approval of the City Engineer."

Good hard burned bricks are used for walls of sewers. Invert blocks of good clay, well burned and salt glazed, like the pipes are used wherever the bottom is wet. Two sizes are made, for 8-inch and 4-inch brick work. (See Plate 15), which blocks are made in two foot lengths. Beveled connection pipe is used. (See Plate 16). The sewers are ventilated by means of holes in the manhole covers. (See Plate 17.)

Plate 18 is a plan and section of a catch-basin, the bottom formed of North river flagstone, the walls of 8-inch brick-work plastered on the inside with cement up to the water line.

Plate 19 represents plans and sections of different styles of extra inlets to catch-basins, by the use of which the number of catch-basins is reduced and the water is taken care of much more easily and to the benefit of the cross walk by reducing the amount of water flowing over them.

Plate 20 gives sections of manholes on pipe sewers also sections of manholes on deep brick sewers with stand pipe used for house connection to equalize the depth of cutting for private drains.

Plate 21 shows a plan and section of cast-iron manhole step.

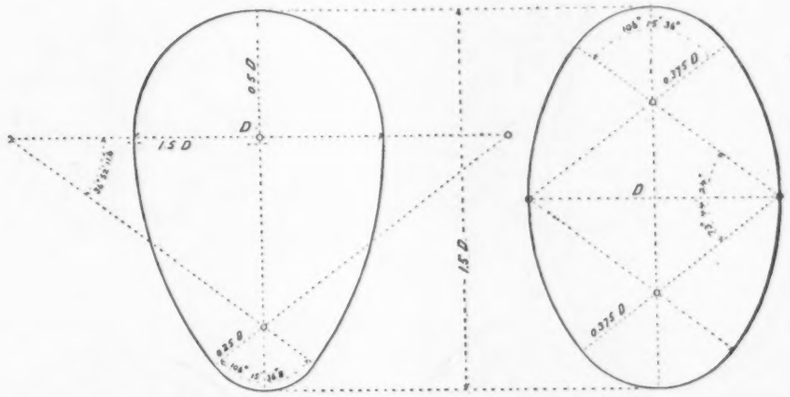
In Plate 22 is represented a section of a paved street on which, for the purpose of illustration, is shown relative positions and sizes of sections of catch-basins with a throttling trap set and connected with a storm sewer; the water and gas pipe; the regular sewer and a private drain with locations of trap, for building close to street line in dotted lines, and in full lines the position most common when the building sets back from the street line, or when there is room to go to one side of the house.

The rules for laying private drains, adopted by the Board of Public Works, May 27, 1882, provides that "the depth of the crown of a drain at the curb line shall be determined by a rise of a quarter of an inch per foot from the crown of the sewer directly opposite," beyond

SECTIONS OF OVAL SEWERS.

TABLE OF ELEMENTS.

NAME.	EGG SHAPE.	FOUR CEN. ELL.
Area	1.1485321 D²	1.1728072 D²
Periphery.	3.9649467 D	3.9649519 D
Mean Hydraulic Radius, when full.	0.289671 D	0.295794 D
Approx. value of D in terms of the dia. of a Circular Sewer of equal capacity of discharge.	0.8388 ∂.	0.8272 ∂.



EGG-SHAPE. FOUR-CENTER ELLIPSE.

Plate 14.

INVERT BLOCKS.

Scale of Inches.

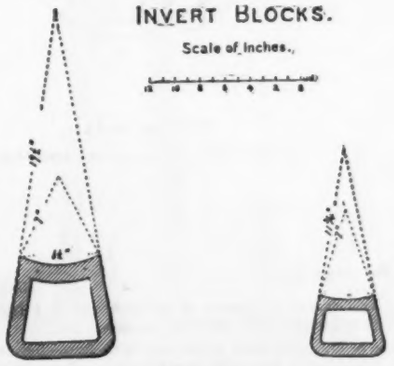


Plate 15.

BEVELED CONNECTIONS.

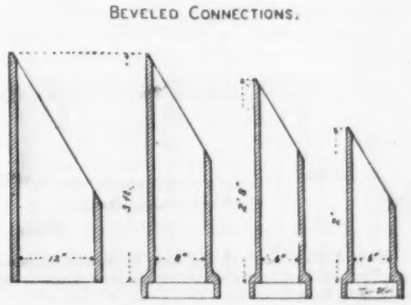


Plate 16.

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this point the owner of the estate can have such grades as he chooses, provided, however, that "the least inclination that can be allowed for water closet, kitchen and all other drains of not over 6 inches diameter, liable to receive solid substances, is one-half an inch in 2 feet; and for cellars or other drains, to receive water only, one-quarter of an inch in 2 feet." The rules and regulations relating to drains are given as follows:—

Private Drains.

Rules and Regulations, adopted by the Board of Public Works, May 27, 1882.

1. Applications for permits to connect with any sewer must be made in writing to the Board of Public Works by the owners of the property to be drained, or by their duly authorized attorneys, and must be accompanied by a clear description of the premises to be drained and of the drains required, and also by certain agreements all as provided in the printed form of application issued by said Board.

2. No one but a drain-layer, duly licensed by the Board of Public Works, will be allowed to make connection with the sewers, nor lay any drains in connection therewith, and any person so licensed shall give personal attention to any work done under his license. He shall also employ none but competent persons to do said work.

3. Notice must be given at the office of said Board, twenty-four hours, if required, before any street or public way can be opened for the purpose of laying a private drain, or before any drain pipe can be extended from work previously done and accepted, or new connections of any kind be made with such work, unless otherwise permitted by the City Engineer.

4. No work of laying drains can be commenced or continued unless the permit is on the ground, in the hands of the drain-layer, or some one employed by him.

RULES FOR LAYING DRAINS.

1. In opening any street or public way, all materials for paving or ballasting must be removed with the least possible injury or loss of the same, and together with the excavated materials from the trenches, must be placed where they will cause the least practicable inconvenience to the public. As little as possible of the trench must be dug until the junction piece into the sewer is found, unless it is first determined to make a new opening into the sewer.

2. Whenever, in the opinion of the City Engineer, or authorized inspector, the sides of the trenches will cave, sheeting and braces must be used to prevent caving.

3. The Board of Public Works, the City Engineer, and their authorized agent, are to have at all times facilities for inspecting the work and materials while under the charge of the drain-layer; and, if required, no pipe or other materials for the drains can be used till they have been examined and approved.

4. The least inclination that can be allowed for water closet, kitchen and all other drains of not over 6 inches diameter, liable to receive solid substances, is ½ an inch in 2 feet; and for cellar or other drains, to receive water only, ¼ of an inch in 2 feet. The depth of the crown of a drain at the curb line shall be determined by a rise of a quarter of an inch per foot from the crown of the sewer directly opposite.

5. The ends of all pipes, not to be immediately connected with, are to be securely stopped by brick and cement, or other water-tight and imperishable materials.

6. All pipes that must be left open to drain cellars areas, yards or gardens, must be connected with suitable catch basins, the bottoms of which must not be less than 2 and ½ feet below the bottom of the outlet pipe, the size, form and construction of which are to be prescribed by the officers named in the second rule. When meat-packing houses, slaughter houses, lard-rendering establishments, hotels or eating-houses, are connected with the sewers, the dimensions of the catch-basins will be required to be of a size, according to the circumstances of the case. When the end of the drain pipe is connected with a temporary wooden catch-basin for draining foundations during the erection of buildings, the drain-layer will be held responsible for dirt or sand getting into the drain or sewer from such temporary catch-basin.

7. No private catch basin can be built in the public street, but must be placed inside of the line of the lot to be drained, except when the sidewalks are excavated and used as cellars.

8. Unless special permit shall be granted by the Board of Public Works, no privy vaults can be connected with the sewers except through an intervening catch-basin, and the discharge pipe of the vault must be high enough above its bottom to effectually prevent anything but the liquid contents of the vault from passing into the drain.

9. The inside of every drain, after it is laid, must be left smooth and perfectly clean, throughout its entire length, and to insure the same a scraper of suitable material, of the shape of the pipe, and slightly less in diameter, shall be drawn through each length of pipe after the same has been laid.

10. In case it shall be necessary to connect a drain pipe with a public sewer where no junction is left in such sewer, the new connection with such sewer can only be made either by one of the employés of the

MANHOLE FRAME AND COVERS.

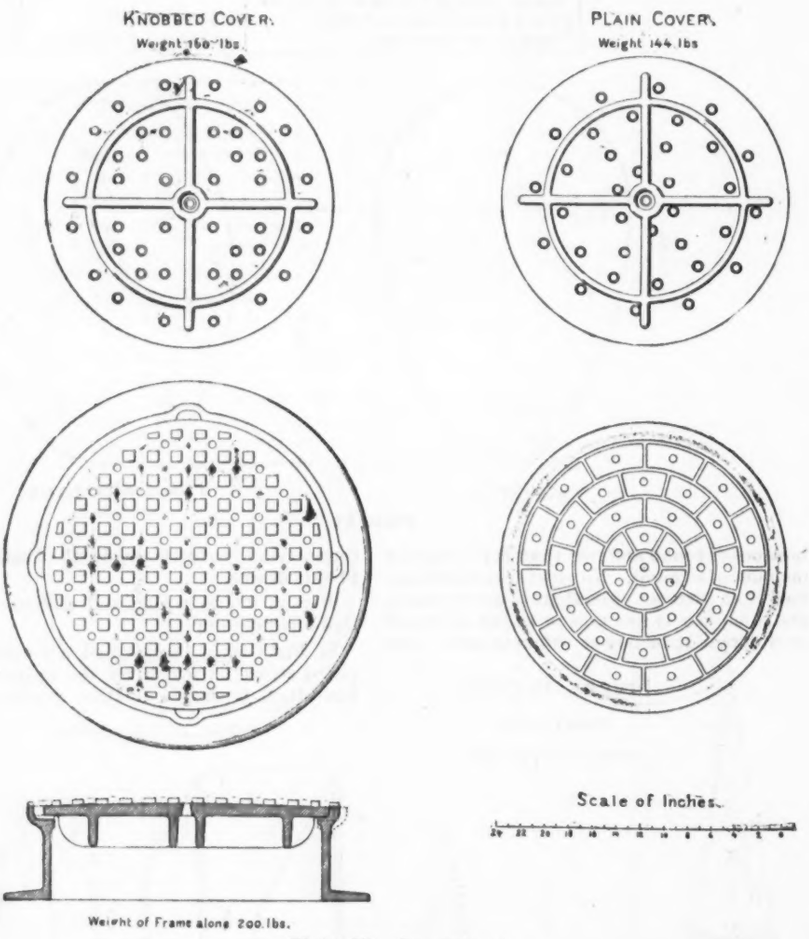


Plate 17. *See page* 291.

PLAN AND SECTION OF CATCH BASIN.

With Modified Form Of Croes' Trap.

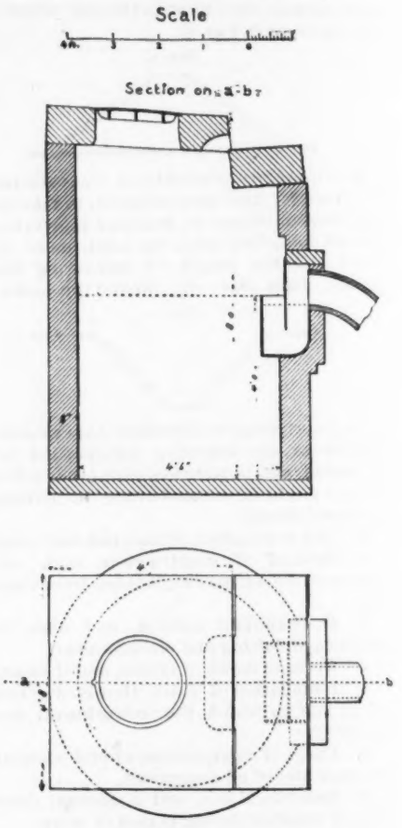


Plate 18. *See page* 291.

SECTIONS OF MODIFIED CROES' TRAP.

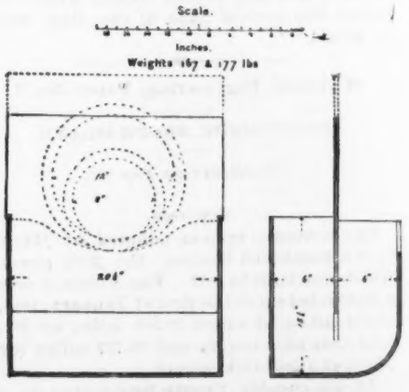


Plate 18a. *See page* 291.

Board of Public Works, or when an officer, named in rule two, is present to see the work done.

11. Whenever it is necessary to disturb a drain in actual use, it must in no case be obstructed without the special direction of one of the officers named in rule two.

12. The back-filling over drains, after they are laid, must be puddled or solidly rammed, and together with the replacing of ballast and paving must be done within forty-eight hours after the completion of that part of the drain lying within the public way, and done so as to make them at least as good as they were before they were disturbed, and to the satisfaction of the Board of Public Works and the officers mentioned in second rule; and the owner will be held responsible for any settlement of the ground which occurs within one year on account of laying said drain. All water and gas pipes must be protected from injury or settling, to the satisfaction of the Engineer.

13. Every drain-layer must enclose any opening

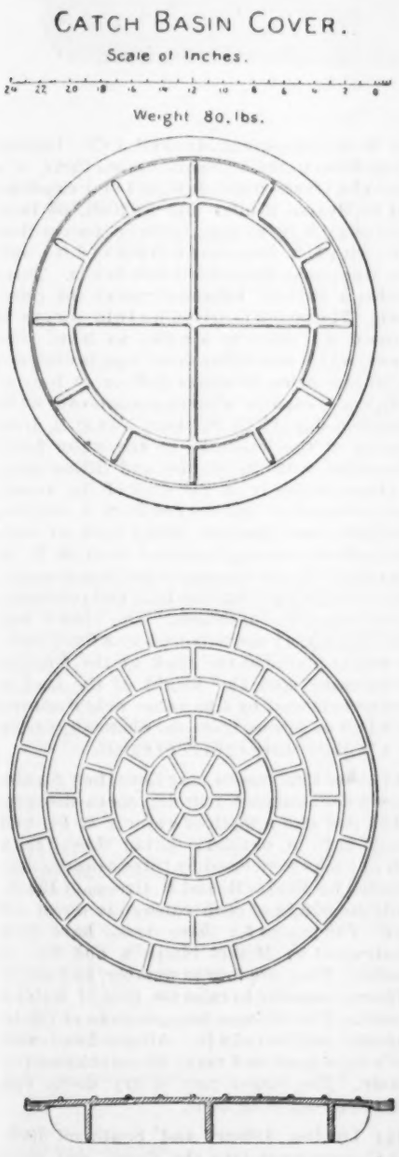


Plate 18b. *See page 291.*

which he may make in the public streets or ways, with sufficient barriers, and must maintain red lights at the same at night, and must take all other necessary precautions to guard the public effectually against all accidents from the beginning to the end of the work; and can only lay drains on condition that he shall use every precaution against accidents to persons, horses, vehicle, or property of any kind.

14. In case a water or gas pipe should come in the way of a drain, the question of passing over or under the water or gas pipe, or of raising or lowering it, must be determined by one of the officers named rule two.

15. All exhausts from steam engines, and all blow-offs from steam boilers, must be first connected with a catch-basin of such dimensions as the officers mentioned in second rule may prescribe, and in no case will they be allowed to connect directly with the private or public sewers, without special permission from the Board of Public Works, or the City Engineer.

16. Such information as the City Engineer has with regard to the position of junctions will be furnished to drain-layers, but at their risk as to the accuracy of the same.

17. When any change of direction is made in the pipe,

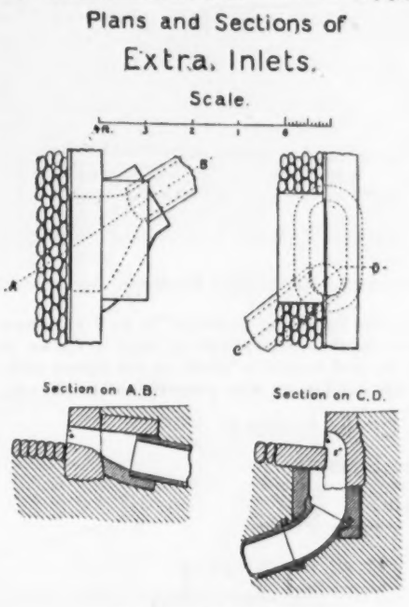


Plate 19. *See page 291.*

either in a horizontal or vertical direction, curves must be used. No pipe can be clipped contrary to the direction of officers mentioned in rule two.

18. All persons are required to place an effectual trap in the line of drain just before it leaves the premises,

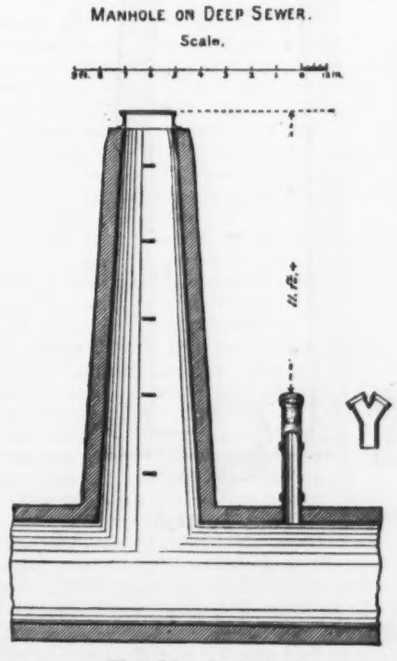


Plate 20a. *See page 291.*

and to make an open connection with a down-spout back of the trap; also, when possible, to make an open connection with the highest part of the soil-pipe within the premises through a large pipe or flue, to a point above the roof of the building, unless special permit to vary from the same shall be granted by the Board of Public Works.

19. The drain-layer shall faithfully observe all the rules for laying drains, as adopted by the Board of Public Works, and, if so directed, shall not cover any of his work until it has been examined and accepted by the proper officer.

20. No drain-layer or person employed by him will be allowed to rest any planking or other material upon any gas or water pipe. Violations of this rule will be sufficient cause for the revocation of license.

21. The drain-layer who obtains the permit shall carefully fill out the blank return provided, whether for new

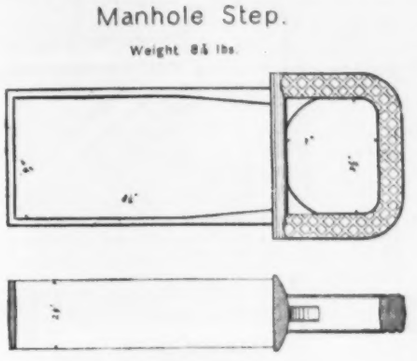


Plate 21. *See page 291.*

work, or for alterations, or additions, and return the same within forty-eight hours after the completion of said work.

22. All work shall be done in such manner and at such times as to interfere as little as possible with the public travel and convenience; and the drain-layer shall conduct his work for this object, as the Engineer may from time to time direct.

23. Every person violating any of the provisions of the foregoing rules shall be liable to pay a fine of not less than twenty, nor more than fifty dollars, and shall be subject to a forfeiture of his license.

[TO BE CONTINUED.]

The Tilbury Deep-Water Docks.

The new Tilbury Docks, London, Eng., consist of a tidal basin with a wide entrance to the river, a main dock, and three subsidiary docks. The main dock has an average length to 1818 ft., with a width of 600 ft. It is connected of the tidal basin by a lock of 700 ft. long and 80 ft. wide, devided into two chambers of 555 ft. and 145 ft. in length respectively. These chambers are inclosed by three pairs of wrought-iron double-skinned lock gates, constructed by Messrs. Joseph Clayton and Sons, of Preston. Each pair of gates weighs about 240 tons, and the width of each leaf is 49 ft.; the depth from the top of gates to the sill is 44 ft. There are twelve hydraulic rams to open and close these gates. The three unlading docks lie parallel to one anothor, and at right angles to the main dock, into which they open in the side opposite to the lock entrance. These docks are each 1800 ft. long; two of them are 250 ft. wide, while the third is 300 ft. Between these three lie two long quays, like peninsulas. The margin of each of the unlading docks is covered with sheds, there being 22 in all, each 300 ft. long and 120 ft. wide. They have wooden floors and iron roofs carried on pillars, the spaces between the pillars being closed by steel coiling shutters. Between the sheds and the dock walls, and also behind the sheds, there are laid lines of rails to admit the railway trucks. These trucks run right through the bases of the hydraulic jib cranes, of which there are 61, constructed by Messrs. Tannett, Walker, and Co., of Leeds. These cranes run on lines of 13 ft. 3 in. gauge, and are fitted with telescopic pipes which connect with unions on the hydraulic mains. These unions occur every 27 ft., and thus the cranes can be exactly adjusted to the hatches of the vessel they are discharging. The jib of each crane will plumb 25 ft. from the face of the quay coping, and will lift 60 ft. above the ground level; the power of the crane is 30 cwt., and the speed 180 ft. a minute.

The whole of the hydraulic power is obtained from an engine house at the north end of the

ILLUSTRATIVE SECTION

Scale of Feet.

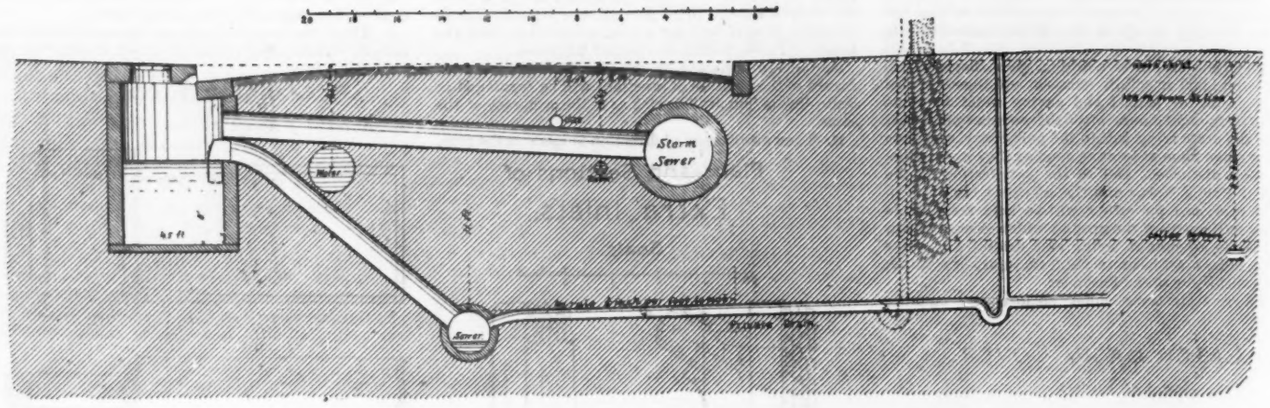


Plate 22.—Illustrating Drainage. *See page* 291

dock. The machinery consists of three pairs of horizontal compound engines of 100 indicated horse-power, each delivering 10,000 gallons an hour. Steam is supplied by three Lancashire boilers measuring 27 ft. by 7 ft. There are two 20 in. accumulators with a stroke of 24 ft., and loaded to 700 lb. on the square inch. This machinery was constructed by Messrs. Sir W. G. Armstrong, Mitchell & Co., limited. In addition to the hydraulic cranes there is a powerful steam crane, designed and constructed by Messrs. Hunter and English, of Bow. The vessel is 110 ft. long between perpendiculars, with 44 ft. beam and a depth of 9 ft., with two transverse water-tight bulk heads. There is also a circular bulkhead under the roller path. The vessel is driven by twin screws at a speed of 4½ miles to 5 miles an hour. The crane, which resembles shear legs, is designed to lift and swing 50 tons at 25 ft or 45 tons at 30 ft. and is capable of placing masts over 100 ft. high in a ship of 50 ft. beam and 32 ft. from the top of the bulwarks to the water level. The crane, with its engine and lifting gear, is placed centrally on the deck of the vessel, and is carried on and worked from a circular revolving steel platform, which rests on cast-steel rollers running on a steel curb 26 ft. in diameter. The curb is supported by a wrought-iron cylinder built into the hull, and connected to the vessel by bulkheads. The shears and their machinery are balanced by a fixed counterweight placed at the back of the framing of the crane, and the weight of the load is counterbalanced by a movable weight moved by a pair of screws 12 in. in diameter, driven by a Willans three-cylinder engine.

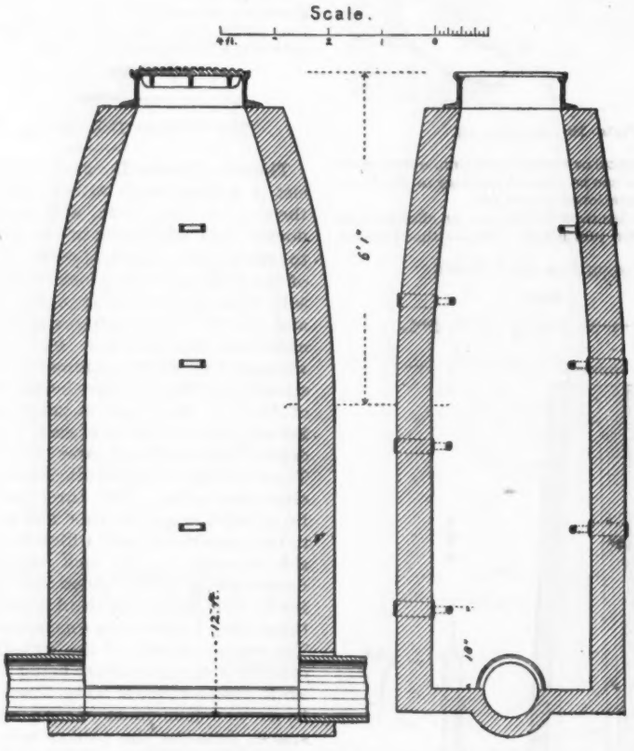
In order that vessels may have their repairs executed on the spot, four dry docks are provided, two with a depth of water of 32 ft., and two of 27 ft. at ordinary spring tides. Each pair of docks is inclosed by three caissons constructed by Messrs R. and H. Green, of Blackwall; the weight of each caisson is about 240 tons. The pumps for these docks have been constructed by Messrs Simpson and Co., of Pimlico. They are four in number, and are of sufficient capacity to raise 650 tons of water a minute. Two of these have suctions of 7 ft. in diameter, and two of 6 ft. All are fitted with Joy's valve gear, and make 250 revolutions per minute. The larger pair of dry docks can be pumped out in an hour.

The London, Tilbury and Southend Railway Company run into the docks, and have made large additions to their line and capital, to meet the expected trade. Agreements have been made by which goods will be delivered by train from the Tilbury Docks at the same price as from those which are nearer.

The whole electric light installation, supplied by Messrs. R. E. Crompton & Co., consists of 80 arc lamps of a power equal to 3,000 candles each, and 1,362 incandescent lamps of powers varying from 16 to 22 candles each. Of the arc lamps some are disposed on lofty masts on the quays and railway sidings, some in the sheds, and others are portable lamps

SECTIONS OF MANHOLE ON PIPE SEWERS.

Scale.



Longitudinal Section. Cross Section

Horizontal Section.

Plate 20. *See page* 291.

for illuminating the decks and surroundings of steamers. Incandescent lamps are distributed throughout the sheds. In these sheds there are a number of attachments to which flexible cables for portable hand lamps may be connected. The engine houses and other buildings, and the hotel, are lit by incandescent lamps. These lights are driven by five engines, of 500 effective horse-power, in two separate engine houses.

The Act of Parliament for this magnificent enterprise received the Royal assent on July 3, 1882, and the promoters, the East and West India Dock Company, immediately set to work, the first sod being cut on July 8th. The first contractors retired from the work, and their places were taken by Messrs. Lucas & Aird, who commenced work on October 27, 1884, and since that time have performed work represented by the following figures:

Excavation	3,275,000 cu. yds.
Concrete	640,000 "
Brickwork	46,000 "
Masonry	260,000 cub. ft.
Shedding	20 acres.
Permanent road laid	22 miles.

The materials used amounted to:

Ballast	700,000 cu. yds.
Bricks	19 millions
Cement	65,000 tons.
Stone	260,000 cu. ft.
Slating	1,056,000 sq. ft.
Ironwork	4,100 tons.
Galvanized sheeting	300,000 sq. ft.
Timber (balk)	1,530,000 cu. ft.
" (planks and boarding)	13,200,000 lin. ft.
Coal and coke	40,500 tons.

The plant employed comprised:

Locomotives	54
Portable engines	35
Pumping engines	46
Steam cranes, pile engines, etc	207
Steam excavators	6
Dredgers	5
Total engines in steam	250
Wagons	1,650
Rails	4,000 tons.
Sleepers	76,000
Temporary road laid	38 miles.
Timber	2,000,000 cu. ft.
Horses	80
Average number of men employed	4,500
Water pumped, 13,000 gallons per minute (maximum quantity).	

Messrs. Manning and Baynes were the engineers.—*Engineering.*

The Halifax (N. S.) Dry Dock.—The construction of the dry dock was begun May 1st. The dock will be capable of receiving the largest ships in her Majesty's navy, including the "Inflexible," a vessel of 8,000 tons It will be 580 feet long on top and 560 feet on the bottom. The width on top will be 102 feet and on the bottom 70 feet.

Mud Pond Dam.

BY WALTER WATSON, C. E., PITTSFIELD, MASS.
Reported for ENGINEERING NEWS.

Mud Pond Dam which broke on the 20th of April causing damage and the loss of seven lives in the little village of East Lee, Mass., was situated high up in the mountains east of the village and by the brook, about four and one-half miles distant therefrom, hard of access and nearly forgotten.

It was built some thirteen years ago by the manufacturers on the stream to give additional storage capacity for use in dry seasons. The site of the reservoir was originally a mountain swamp of about fifty acres, and with small brooks running down separate valleys at either end of it, these brooks coming together again about three and one-half miles below, and about one miles above the village. Originally the flow of water was controlled by means of gates in the dam which broke, and the dam at the other end of the pond was without such arrangements, but owing to objections made by certain riparian owners, it was fitted with the necessary gates, and the flow was regulated at that point, and the gate and all other arrangements at the broken dam had fallen into disuse.

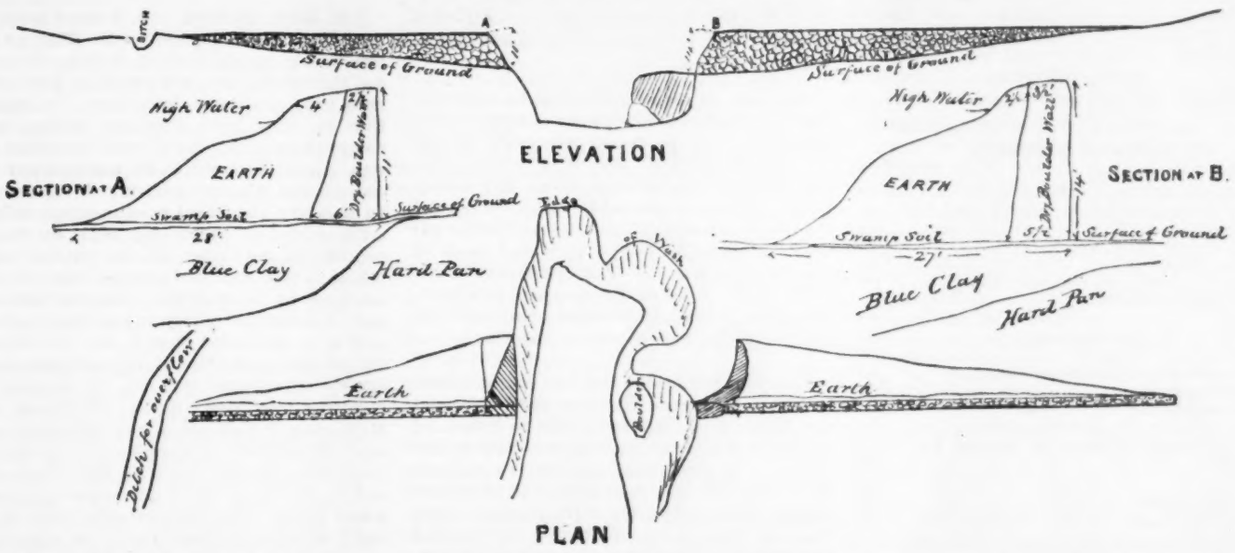
These arrangements consisted of an iron cylinder passing through the dam and built into it with, maybe, a few more stones about it than in the other portions of the dam, but they were all undressed boulders used without mortar, and were thus an item of weakness rather than of strength. Onto the upper end of this cylinder were fitted gates which operated from a platform built over the water and supported on four wooden posts set in the dam and ground, but these had rotted off and the platform had fallen into the water.

The main portion of the dam as shown in the accompanying sketch, was simply a dry wall of rough boulders laid together without much care about 6 feet thick at the bottom, and 3 feet at the top, and fourteen or fifteen feet high with a backing of earth on the upper side, which originally was apparently about 6 feet wide on top and with its natural slope, but at the time of the break the earth bank was about 3 feet wide on top and 23 feet at the bottom. The high water line was about 3 feet below the crest of the wall, and, in order that the water should never by any accident reach the top of the dam, a ditch about 7 feet wide and 3 feet deep was scraped in the soil of the hillside near the northerly end of the dam. The structure was about 325 feet long. The earth of which the embankment was built was obtained from a borrow-pit near the northerly end and was passibly good material except that evidently very little care had been taken to exclude foreign substances.

The foundation of this dam was the natural surface of the ground, except that for the stone wall a trench *may* have been dug through the top soil. The material under the dam consisted of a layer of swamp soil a foot or more thick underlayed by a blue clay with a slight admixture of sand (which would have made a good puddle if so used) and this latter underlaid by hard pan with a few boulders. A short distance above the dam, and at the edge of the washout of the bottom of the pond, the mud or top soil was underlayed by numerous boulders which prevented the wash from extending further into the pond.

At the time of examination water was running under and through the stone wall on the southerly side of the break from the hillside above and the adjacent ground was quite wet and swampy. On the northerly side of the break the ground was dryer and more firm. The southerly portion of the wall was also bulged quite a little. The break in the dam is an opening about 70 feet wide at the foot, and the soil is washed out to a depth of about 15 feet for the whole width, except that a small tongue of land protected by a large boulder was left on the southerly side.

The washout extended back into the former pond about 100 feet. Further comment as to the causes of the break seem to be unnecessary.



THE River and Harbor Bill, appropriating $15,000,000, passed the House of Representatives on Thursday. The New Croton Aqueduct Bill, adding three new Commissioners to the Board, was passed by both Houses at Albany, on Thursday, by a vote of ninety-two to five. One of the new Commissioners must be a Civil Engineer.

PETROLEUM IN NEW MEXICO.—The report that a flowing petroleum well has been discovered in New Mexico between the mining villages of Golden and Wallace, is stated by the Chicago *Times* to have been confirmed. Samples have been tested at Santa Fé. The oil flows through tubing 55 feet in depth, and the flow is reported to be copious and steady. The crude oil burns freely and with a good flame. "Several claims have already been located in the neighborhood of the well."

Prison.—Wahlman & Grip, of Ishpeming, have been awarded the contract for the erection of the branch state prison buildings at Marquette, Mich. Their bid was $135,817. The bids ran as high as $226,000.

ENGINEERING NEWS
AND
AMERICAN CONTRACT JOURNAL.

TRIBUNE BUILDING, - NEW YORK CITY.

THE ENGINEERING NEWS PUBLISHING CO. PROPRIETOR.

VOL. XV. Saturday, May 8, 1886.

CONDUCTED BY

GEO. H. FROST, - - - Assoc. Am. Soc. C. E.
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WE wish to buy all the copies of ENGINEERING NEWS of March 27th and April 3rd, 1886, that are offered, and will pay 12 cents in cash, for each copy received, or will send the "Engineers' Field Book" for the two.

A DOUBLE page Plate of the Competitive Designs of the Hawkesbury Bridge accompanies this week's issue.

THE Government subsidy of $800,000 for carrying the mails to South America passed the Senate on Tuesday.

ACCORDING to a "special" to the Philadelphia *Press*, of the 29th ult., the South Penn. R. R. construction is soon to be started up again. Dr. Hostetter is reported as predicting active work by June 1st and its completion by April 1st, 1887.

IN reply to inquiries concerning Wellingtons's new edition of "Economic Location of Railways," we are obliged to say the author writes us that "the type writer copy of the manuscript will be ready by the end of June." This means that the book will not be in the market until next fall. If any parties who have claims on us on account of this long deferred publication wish to change the order or have money refunded, they will please notify us at any time.

SOME experiments have been successfully made on the Indus Valley railway in running locomotives fired with petroleum; and it seems likely that the frontier railway engines will before long derive their fuel from the oil wells near Sibi.

THE Memphis and Little Rock R. R., on May 1st, was under water from Madison on the St. Francis River to Hopefield opposite Memphis and in many places there was from 4 to 6 feet of water over the track.

THE Pennsylvania R. R. Co. now issues excursion tickets between New York and Washington for $10.00, and between New York and Baltimore for $8.00. "Stop-overs" at Philadelphia and Baltimore are allowed, and these rates will be extended to all the most important stations on the line.

ENGLISH iron trade circles are a little excited over the result of the awards of recent Italian steel rail contracts, in which not a single contract went to England. The total 27,800 tons at, say, an average of 105 francs, amounts to nearly $300,000, not much for the great English companies, but yet is sufficient to create some misgivings as to future competition.

THE war in cable rates has brought the price down to twelve cents per word by the old companies, and to twenty-five cents by the new Mackay-Bennett Co. It is now simply a question of financial endurance. If the combined companies can whip the Commercial Company into submission, the losses of the war must be made up by the increased rates of the future monopoly. The Commercial Company, on the basis of this prospect appeals to the public to support its twenty-five cent rate as against the twelve cents of the others.

THE principal locomotive and wagon manufacturers of Austria-Hungary have informed the Minister of Commerce that in default of orders they will be under the necessity of discharging a great number of their workmen. They ask that the Government will distribute among them orders for rolling stock which they will require, over the next twelve months to assist them in tiding over the dull times. The Minister has summoned a meeting of the representatives of the railways to consider what can be done. That is paternal government certainly.

THE Eads Ship Railway bill has been reported favorably in the Senate. The following changes are made from the bill reported in the House. The guarantee is reduced from $37,500,000 to $7,500,000, not more than $2,500,000 to be paid the first year, and not more than $1,500,000 in any subsequent year, and the payments to be limited to five years. The company is also to transport safely a loaded vessel weighing not less than 6,000 tons before the guarantee becomes operative, and during the second year a vessel weighing 7,000 tons.

AN old reader of ENGINEERING NEWS remarking on the demolition of the building occupied by Delmonico down town, for the new office building of the Equitable Life Insurance Company, told us that it was built about 1850 for a wholesale store by Bowen, Macname & Co., and that, the day it was thrown open to the public, as a boy he wandered in and heard a couple of men about forty-five or fifty say that it was absurd to expect the wholesale business to ever come as far up Broadway as that and no business could stand so large and expensive a structure. It is now somewhat of a walk up Broadway to the nearest wholesale store, and nearly 2½ miles to the farthest one, which at that time would have been very near the country. The building itself, after having two stories and a mansard added to it, is now being torn down to make place for one that is to cover nearly the entire block, and will be ten stories high.

AN enthusiastic South African has written to the *Pall Mall Gazette* advocating a north and south railroad from Kimberly, the northern terminus of the Cape of Good Hope system, to meet the road extending south from Cairo. He asserts that the distance is a little over 3,000 miles. The scheme could be carried through for less than $50,000,000. If the project is ever seriously entertained it would be best to rather more than double the estimate.

This scheme, like the "Three Americas Railroad," will be feasible when capital can be obtained, but unlike the plan of Mr. Helper it will not for some generations serve a rich and prosperous people on any part of its line, and the only people who would be likely to put money into it, the English, are not educated to building cheap railroads to develope a country.

THE labor question is in a more unsettled condition than it was last week. May 1st was practically a half or whole holiday throughout the country to enable workingmen to discuss the eight hour question. The results thus far have been numerous strikes, some compromises, with many still unsettled disputes, and probably 50,000 unemployed mechanics and laborers awaiting developments. In this city the Third avenue street railway strike ended on Wednesday night by the unconditional surrender of the strikers' committee, which action, however, has not been accepted by the strikers. The railroad company lost $150,000 in the twenty day's contest, and it is estimated that it cost the strikers $50,000 besides the loss of many situations and other contingences that can be imagined as resulting from such a fight. In Chicago and Milwaukee the situation has been more serious. In addition to troubles arising directly from labor disputes, the authorities have had to face the rising of an Anarchist mob, composed of the most disreputable dregs of society, which took advantage of the moment to attempt the incitement to plunder and destroy the property and lives of peaceful citizens, which attempt in Chicago resulted in the death of one policeman and the serious wounding of many more, but which also resulted in the arrest of the Anarchist leaders and their probable relegation to quarters which will relieve society of their pestilential presence for many years to come. It will be noticed that the most troublesome element yet encountered is made up exclusively of foreigners, quite recent arrivals, not yet conversant with the English language, and who apparently have no proper appreciation of their advantages under this government. The thought at once arises that a quarantine for this infected rubbish might well be established.

THE extension of the Northern Division of the Southern Pacific R. R. has been finally decided upon by the Southern Pacific Company. The present terminus of this division is at the town of Soledad, in Monterey county. The extension will run from 'Frisco along the right bank of the Salinas river to the divide between this river and the Southern river flowing through San Luis Obispo county. Crossing this divide the line leaves Monterey county and enters San Luis Obispo county. This as well as the other counties traversed are rich in agriculture and fruit-raising. The road passes through the city of San Luis Obispo, crosses the Santa Maria river and then ascends the Santa Inez mountains, using the Gaviota Pass. It has passed before reaching this point the fertile and well watered valley of the Santa Inez river. Then the road enters into Santa Barbara county, which is so celebrated for its lovely climate and its large yield of the finest

varieties of fruit. The line runs nearer the coast than before. The Carpentaria district, well known as the natural home of the lima bean, is crossed by the road, It then enters Ventura county and finally connects at Newhall, Los Angeles county, situated on the eastern slope of the Coast Range and being a station of the main line of the Southern Pacific R. R. with this road. This road will be eventually the main Southern overland route; it avoids the dangerous Soledad Cañon and the Tehachapi Pass. The new road will be comparatively level, and with the exception of two or three places will be free from steep grades, and it will be about 75 miles shorter from San Francisco to Los Angeles than the present road through the San Joaquin valley. The trains could run also at a higher speed.

There is some doubt yet whether Newhall or San Fernando will be the connecting point with the old road, as there are difficulties about right of way through the Newhall ranch. Five-hundred men are at work at Soledad, and as soon as the Yosemite Valley railroad is finished—probably this week—the forces from there will go to Soledad.

The old project of continuing the line south from Soledad, crossing the Coast Range by the Polonio Pass, and connecting with the present Southern overland line near Bakersfield in the San Joaquin Valley has also been revived; but will not be built at present; it does not offer the same advantages as the other line, as Bakersfield is north of Tehachapi Pass and Soledad Cañon.

THE German River Shipping Association reports that within the last ten years the shipment of goods has doubled on the Rhine, trebled on the Elbe near Hamburg, and quadrupled on the Oder near Stettin. All of these rivers have been improved by the German Government. The Oder has had its depth dredged out to 20 feet from Stettin to the sea, so that it is available for vessels drawing 19 feet. The Elbe has had its navigation improved both by dredging to a depth of 5 or more feet, and laying down a chain for chain towing, while the Rhine has had very small additions made to its depth. The state of the Elbe in 1870 may be judged of from the fact that a commission in that year reported a plan to increase the depth of the river to 2 *feet* 10 *inches*. The display of cheap wit about Macadam, etc., that would have greeted such a report in this enlightened country can easily be imagined. Yet the up freight on this river from Hamburg to Dresden 359 miles is at the rate of $\frac{64}{100}$ cents per ton mile, and the down freight $\frac{12}{100}$ while the lowest railroad freight is at the rate of $\frac{85}{100}$ cents per ton mile with terminal charges varying from 28 to 48 cents per ton. If we assume a mean terminal charge, (and as the terminal charges increases with the length of travel, this is liberal enough,) the up river freight will be about two-thirds of the cheapest railroad freight, and the down river freight about one-fifth of the railroad freight.

The Hudson Tunnel Experiment.

Before the Commissioners of Patents.

In the matter of the application of Dewitt C. Haskin for a patent for an Improvement in the Construction of Tunnels, filed January 31, 1883. Serial No. 83.

On this 21st day of June, 1883, before the subscriber a Notary Public in and for said county, the above named Dewitt C. Haskin being duly sworn deposes and says that the description referred to in the *Scientific American Supplement*, mentioned in official letters of April 23rd and June 2nd, 1883, relates only to experimental works carried on by deponent prior to making application for patent; that prior to his invention no mode of erecting tunnels in loose muds and sands under the beds of rivers had been known, except by the use of expensive shields and coffer dams; that after the first conception of the present invention by him, while he had faith and fully believed that it was a practical and operative method, still he was advised by various competent and experienced engineers that his invention was totally impracticable and worthless. Deponent therefore decided to postpone his application for a patent until he could ascertain by actual experiment whether his invention was really practical or not. These experimental works were begun in 1880 by an attempt to construct a tunnel under the Hudson river from Jersey City, N. J., to the City of New York. The prosecution of said experimental works was carried on subject to many extraordinary difficulties, as it was necessary for the workmen to make new experiments at almost every step in order to find out the best modes of fitting in the plates, the best modes of applying the air pressure, the best modes of excavating for the plates, the best modes of temporarily supporting the structure, and of finishing the same to make it practical and permanent. Parts of the experimental work proved defective and had to be altered. At one time during the progress of these experiments a portion of the work gave way, the river water and mud came into the tunnel and several workmen lost their lives. The restoration and rebuilding of this part of the work occupied a considerable time; and it was not until November, 1882, that deponent had succeeded in experimentally demonstrating that his invention was practical and valuable, so far as related to the construction of tunnels and excavations in tenacious silt, which is the character of the soil on the New Jersey side of the Hudson river where deponent's experimental works were conducted.

Within a reasonable time after deponent had thus experimentally ascertained that his said invention was practical, to wit, on the 31st of January, 1883, he filed his present application for a patent, which he prays may now be allowed.

DEWITT C. HASKIN.

[L. S.] EDGAR TATE, Notary Public, New York.

Mr D. C. Haskin the well known projector of the Hudson River Tunnel has brought suit against John Anderson formerly superintendent of that work for infringment of patent on the "pilot tunnel" there used.

The first work upon the tunnel was attempted without the use of plates of any description. After the original air-lock had been jacked through the wall of the shaft until it projected a few inches beyond the outer surface, a small excavation was made in the silt proper. The air-pressure kept this chamber open for a few days, but the silt became rebellious and caved in.

Next, the attempt was made with plates to hold the material, and a tube 6 feet in diameter was built around the air-lock and joined to the masonry. From that time forward plates were used, and it is extremely doubtful if a foot of tunnel could have been built at the New Jersey end without them, and it is absolutely certain that a start would never have been made through the sand at the New York end, had they not been resorted to. So we see the necessity for the plates and also for the compressed air which merely served to keep things in a kind of unstable equilibrium. Hence the importance of the question: who first thought of the plates? becomes apparent. If the idea originated with Mr. Haskin, then his patent is sound (leaving out of consideration, of course, the time intervening between the practical demonstration of his idea and the filing of his specification, and leaving out also the English patent granted to a certain Lord Cockrane about 1830); but if the idea was conceived by one of his workmen, who made "new experiments at almost every step," then the benefit would naturally accrue to that workman, provided he was not engaged with the understanding that the creation of his brain as well as the work of his hands should be the property of his employer.

Among the employés was Mr. Anderson the Superintendent. Some eight and ten years before he had personally used plates under similar conditions in sinking the cylinders for the Omaha bridge, and for the South street bridge, Philadelphia. What more natural than that he should see the resemblance between the three cases, and should suggest the use of plates in the tunnel? Naturally he was a man of ideas—one of the quickest to conceive, and quickest to execute we ever knew. In building the north tunnel he found it impossible to keep to grade owing to unequal settling, due to difference in consistency of the silt directly over the crown, and he devised the pilot which not only presented a firm center from which to brace the plates but also gave an indication of the nature of the material in advance of the heading. That portion of the north tunnel built before the introduction of the pilot looks as if it had selected its choice of grade, and had changed its mind about every 10 feet, while that built afterward was kept to grade without trouble. This one instance is an all-sufficient illustration.

During the subsequent progress of the work we never heard of a single instance in which Mr. Haskin originated a practical method of surmounting new obstacles. Personally he was unacquainted with the appearance of the heading of his own tunnel; his office was upon firm ground; there he planned and there he received the description from his assistants, of the work below. Although he was prosecuting a series of gigantic "experimental" researches upon the subject of submarine tunneling by aid of compressed air, his visits to his laboratory were exceedingly few and far between. Mr. Haskin visited the interior of the Hudson river Tunnel just twice. Now did the idea of the plates come from Mr. Anderson who had seen them used before, or did it come from Mr. Haskin whose familiarity with the requirements may be judged from the above?

The period at which an experiment ceases to be experimental is in this case of great moment. In the *Scientific American* of May 8, 1880, nearly three years before the filing of Mr. Haskin's patent are several views showing the method of carrying on the work in the tunnel. One view shows the silt at the heading divided into steps upon which are seen men putting in plates to favor the iron sheathing. A short distance in the rear (to the left in the picture) is shown the end of the completed masonry with plates upon the exterior. This plan was continued until the pilot made its appearance, when the plates were supported from the pilot as a foundation. Another view, looking toward the heading, shows the same manner of using the plates. In describing the engraving the accompanying article says: "This iron is ¼-inch thick, and the plates are 2 feet 6 inches wide; some of them are 3 feet and some 6 feet long and they have 2½ inch flanges on each side through which each plate is bolted on all four sides to those around it. Additional strength is attained by the breaking of the joints as the different sections are bolted together." Afterward the size of the plates was reduced whenever necessary. This method of using the plates was never changed; no other material was tried, no other shape was used. The same plates were of necessity used, and the last plate put in could hold forth its hand and truthfully say, "brother," to the plate first inserted. So we find that years of "experimental" work resulted in no change nor was any change in the regular routine ever attempted. We cannot conceive the whereabouts of these "experiments" during all that time.

We never knew until we had read the above document that Mr. Haskin was "experimenting." In our ignorance we thought he was trying to build a tunnel under the Hudson River between New York and Jersey City. But now we are enlightened; we know that he was merely superintending a few "experiments" and we presume that some day he will practically undertake the work of constructing the tunnel, We wonder if the Coroner's jury when investigating the accident,

knew that the mishap was the result of "experimental work," conducted theoretically by the General Manager in his safe quarters and practically by his workmen, "almost every day," in the unsafe heading, and we also wonder if those gentlemen who contributed money to build a tunnel knew that they were only furnishing the means for equipping and running a mammoth experimental station.

The cylinders put in to strengthen the abutment of the Chestnut street bridge, Philadelphia, were built up of plates, and the roof of the excavation for the recently completed Knickerbocker avenue sewer, in Brooklyn, was composed of plates. Both of these works were constructed by Messrs. Anderson & Barr, against whom Mr. Haskin has begun suit for infringement of his patent. In 1886, Mr. Anderson is compelled to defend himself in the courts, because he employs certain plates identical with those he had personally used sixteen years before, and all for the reason that the well-known Mr. Haskin had, in the meantime, obtained a patent covering these plates, by presenting to the Commissioner of Patents the sworn statement given above.

The Hawkesbury Bridge.

Either the Union Bridge Company, of New York, has very much under-estimated the work to be done in the construction of the Hawksbury Bridge, in New South Wales, or our English engineers have not only over-estimated it but put on a big sum for possible difficulties in constructing foundations 185 feet below high water. The site of the bridge is across the tidal estuary about thirty miles above Sydney, and the depth of mud and sand very great. The Union Company's tender of £327,000 was accepted as the lowest; but in accepting it, alterations requiring an increase of £40,000 were we believe stipulated. This will bring the cost up to £367,000, without any of the extras which are no doubt to be built up as the work proceeds. How the New South Wales people will like the bridge twenty years after its completion of course remains to be seen, but how they will like some kinds of tension members connected with it, commonly called wire pullers, will perhaps be seen much earlier. It is to be regretted that this bridge is not to be constructed by English constructors; but they are better without it if they could not get a fair price in a fair way. English firms of repute do not seek extras; but it must also be said that some of them want what, in the face of world-wide competition, are prohibitory prices for what they do.—*The Engineer*,

An illustrated description of the location and design of the important structure above referred to will be found on Page 98 *ante* of this volume of ENGINEERING NEWS with a brief history of its inception and the call for bids for construction. Being a very important structure, the Union Bridge Company at once entered into active competition for obtaining the contract for its erection. A member of the firm visited England, and another, accompanied by Mr. Jno. Anderson of the now justly celebrated firm of Anderson & Barr, sailed for South Australia to carefully inspect the site and conditions of the proposed structure. The result was the well considered bid of the Union Bridge Company, based on the expert judgment backed by a sub-contract for the pier sinking by Anderson & Barr, and the resulting success in taking the whole contract from all competitors. We publish this week a double page sheet, for which we are indebted to *Engineering*, showing all the competing designs, and it does not require even an expert to decide on the comparative merits of each.

The Union Bridge Company have reduced the number of piers to a minimum; the details of the caisson are shown on page 100 *ante* and the selection of the successful design by the committee of eminent English engineers, whose names are given on page 98 *ante*, ought to be a very sufficient answer to the imputations of the above note from our disgruntled contemporary.

The reason why an American firm was awarded an important bridge contract by an English committee, deciding upon the merits of a dozen or more designs, mostly submitted by Englishmen, was that the American bridge was the best and cheapest offered, the contractors were known to be just as responsible financially, and as honorable in their business methods, as any of the English competing firms; American bridges as well as locomotives are not unknown in Australia, and there was no alternative but to award the contract as it was. An inquiry at the office of the successful company as to "extras" was met with the statement that they had not heard of any, and there probably would not be any unless the Australian authorities ordered them; the specifications provided for all that.

In order to make the history of this bridge as complete as possible as it progresses, we herewith reprint a portion of the article accompanying the plate of designs from *Engineering:*

New South Wales is to be congratulated on having selected a gauge of railway which has outlived other widths, and become the standard in the countries where it has been introduced; we see no reason why, when the battle of the gauges comes to be fought out in Australia, the choice should be reversed in her case, great as may be the expenditure of conversion of those colonies who did not lay down the inevitable 4 feet 8½-inch gauge in the first instance.

The most important extension now under construction is the Southern and Northern Junction Railway of New South Wales, about ninety miles in length, starting from the existing railway running out of Sydney and crossing the Hawkesbury river on its route to join the northern system at Newcastle. This length is being built as a first-class double line of railway in anticipation of the traffic not only between the two principal business centers of the colony, but that which may be expected to follow the opening of the through route between South Australia and Queensland.

The construction of a railway in proximity to the east coast necessitates some very heavy works, but its importance as a communication between the Southern and Northern Railway systems of New South Wales fully justifies an outlay in excess of the ordinary mileage cost of existing lines.

The works now in hand on this length have considerable engineering interests; tunnels and rock-cutting continually occur, and almost immediately after leaving the junction with the present railway, the Parramatta river is crossed by a wrought-iron bridge with six openings of 150 feet each, whilst on other parts of the route, in addition to long lengths of timber trestle-work approaches, twenty-six openings of 60 feet, with wrought-iron girders, are used for crossing the creeks, which become flooded in the rainy season.

The most interesting undertaking, however, is the bridge crossing the Hawkesbury river, which when completed will be the biggest work of its kind in the southern hemisphere. The point of crossing selected is about thirty-six miles from Sydney, fifteen from the sea, and a few miles below where the great north road traffic is taken across at Wiseman's Ferry. After passing over a shallow branch of the river the railway enters a tunnel through Long Island, and emerges on the bank of the main channel about 45 feet above high water: after passing over the bridge it will enter a side cutting on the projecting promontory of Mullet Point, and leave the banks of the river at the head of a short creek running back from the main stream. At the site of crossing, the scenery is extremely wild and picturesque, high rocky cliffs generally springing direct from the water's edge, backed by hills rising to 600 feet close to the river, the banks of the latter being cut up into innumerable creeks with occasional islands, the country round being still uncleared and covered with timber. The tide at this point has a range of 3 feet to 7 feet, and under certain conditions runs at the rate of three to four knots an hour. The Hawkesbury river rises on the eastern slopes of the Blue mountains, and with its branches, together 330 miles, drains an area of about 8,700 square miles, it being the largest river in New South Wales falling into the Pacific. Its upper parts are subject to great variations of volume between the dry and rainy seasons, the lower are navigable for small steamers which make Wiseman's Ferry the loading port for fruit and garden produce for the Sydney markets. Between the site of the bridge and the sea there is ample depth for the largest vessels, Broken Bay, within the entrance at Hawkesbury Heads, being used as a harbor of refuge.

After having given long consideration to different systems of railway communication suitable to the case, the Colonial Secretary, at the instance of the Minister of Public Works, instructed Sir Saul Samuel, K. C. M. G., to publicly advertise for tenders and designs for the complete construction with a year's maintenance of a bridge 2,896 feet between abutments, having a clear headway above high water of 40 feet, to carry a double line of railway 4 feet 8½-inch gauge, the conditions stipulating the superstructure to be of steel and the piers to be founded at an indicated depth, in some cases 170 feet below water level.

In response, fourteen tenders for the work complete, accompanied by designs, were received by the 1st of June last, the amounts of the tenders (excluding the Phœnix Bridge Company's offer, which was for iron) ranging from £296,350 to £702,384, and the time for completion from two to four years.

A bare glance at the designs shows either the piers are unnecessarily massive in some cases, or undoubtedly too slender in others; this great want of uniformity is due, no doubt, to a limiting pressure on the foundations not being specified in the conditions, though minute instructions were given for superstructure. It seems probable that this lack of information or conditions regarding the doubtful and most costly portion of the work, may be the reason why so few firms known as bridge builders appear to have availed themselves of the opportunity of tendering, so reducing the competition to the disadvantage of the colony.

The result, as our readers are probably aware, is that the contract has been placed with the Union Bridge Company, of New York, whose offer was recommended both by the Committee of Engineers appointed to select one design, and by Sir John Fowler, K. C. M. G., the consulting engineer to the colony. We hope, before long, to illustrate fully the structure which the Union Bridge Company propose to erect.

Local requirements and additions recommended by the committee may somewhat modify the details of some of the parts and so increase the cost, but allowing for these additions the committee reported that they still considered the selected tender the most economical of those which complied with the conditions, and met their views of stability. In addition to the selected bridge we hope to illustrate shortly as typical of Continental and British practice, those designs specially commended by the Committee and Sir John Fowler.

In conclusion, we cannot help expressing our regret that so few high-class designs were received; the majority either fail to fulfill the conditions or have been carried out in a manner that left no chance of success. In a case of this kind, where the distance was too great to expect contractors to make a personal examination of the site, a higher class of design and a greater equality of the amounts of the tenders would have been attained if the conditions had included the alternative of either contractor's tenders on their own plans, or upon one by the Engineer-in-Chief for Railways, whose success in other works and long local experience could not fail to have been embodied in his design, giving confidence to those who no doubt under these circumstances would have tendered, and assisting others who proposed modifications or alternatives, and so enabling a selection to be made from the majority instead of the minority of firms capable of carrying out so important a work.

This is very kind and thoughtful on the part of our contemporary to thus "let down easy" its friends, who had not the enterprise to risk their money and time in obtaining intelligent data upon which to bid for the work. In this connection we note that the "Messrs. Arrol Bros., Glasgow," who submit Designs No. 1 and 2, are not the Arrols who are building the Forth Bridge.

PERSONAL.

JOHN DONNELLY is the newly elected City Engineer of Kansas City, Mo.

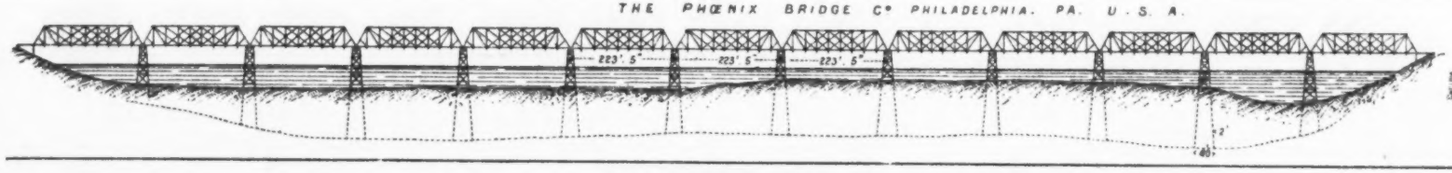
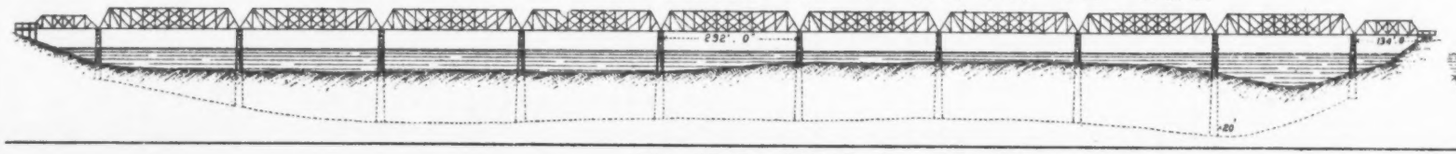
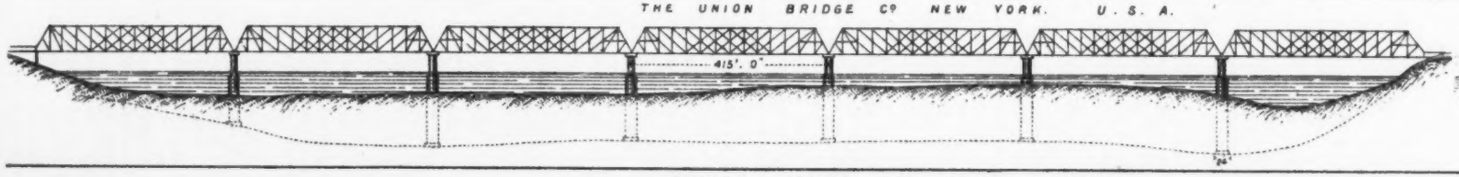
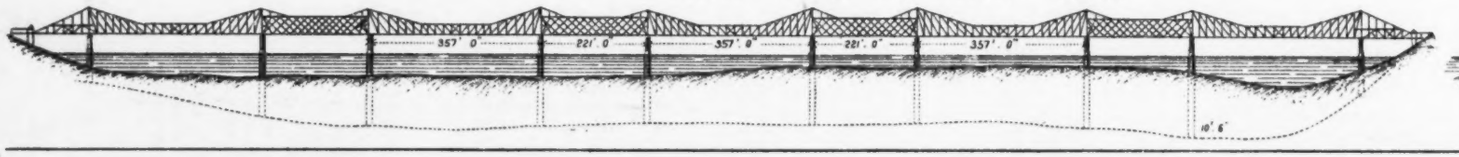
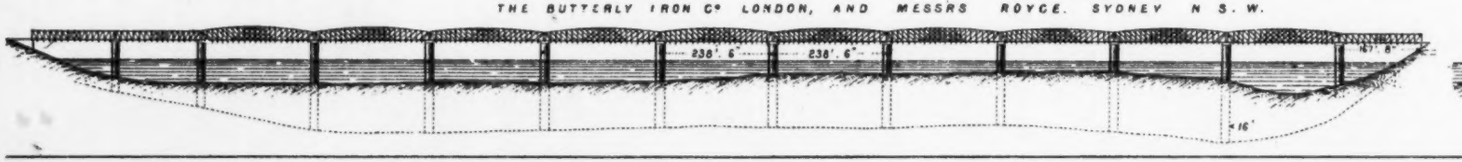
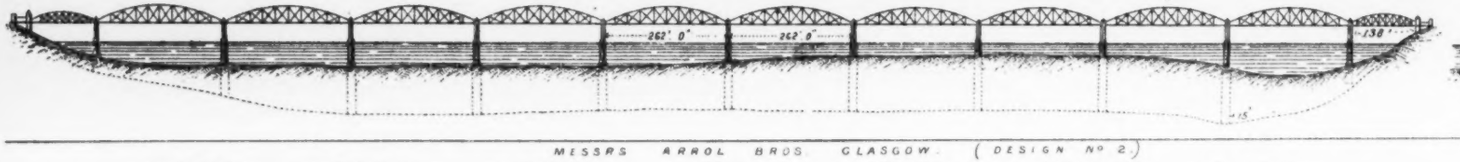
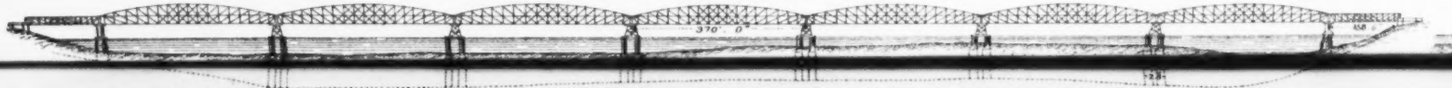
M. BOYER, Director of the Panama Canal Works, died last week.

The salary of the City Surveyor of Rochester, N. Y., has been fixed at $2,300; that of the assistant surveyor has been raised to $1,500; an increase of $300 and the draughtsman will receive $900.

MR. JOHN ANDERSON of Anderson & Barr, will sail from San Francisco June 5th, for Australia, to commence operations on the foundations of the Hawkesbury Bridge. The contractors plant is already loaded on the ship *Anglo India*, to leave New York May 10th.

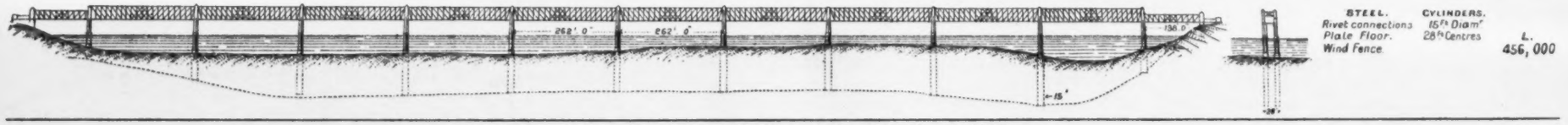
JOHN HENNEY, Jr., Superintendent of Motive Power on the N. Y., N. H. & H. R. R., was a visitor at the meeting of the American Society on Wednesday evening, taking part in the discussion on Mr. Dorsey's paper by contributing the records of several of the best locomotives of his road.

COMPETITIVE DESIGNS FOR THE HAWKESBURY RIVER BRIDGE, NEW SOUTH WALES.

ELEVATIONS	SECTIONS	REMARKS. SUPERSTRUCTURE	REMARKS. PIER AT BASE	AMT OF TENDER
THE PHŒNIX BRIDGE Co PHILADELPHIA. PA. U. S. A. 		IRON. Phœnix construction.	PHŒNIX COLUMNS, Cast Iron Screws.	L. 280, 800
THE EDGEMOOR IRON Co WILMINGTON. DEL. U. S. A. 		STEEL. Pin connections for Eye-bars & Struts, Rivets elsewhere. Timber cross Sleeper Floor.	CYLINDERS. 20Ft Diam.r 40Ft Centres.	L. 296,350
THE UNION BRIDGE Co NEW YORK. U. S. A. 		STEEL. Pin connections for Eye bars & Struts, Rivets elsewhere. Timber cross Sleeper Floor	CAISSON. 24Ft by 52Ft Rounded ends	L. 327, 000
MESSRS FFORDE AND YOUNG. LONDON 		STEEL. Rivet connections	CYLINDERS. 10Ft 6Ins Diam.r 28Ft centres.	L. 377,500
THE BUTTERLY IRON Co LONDON, AND MESSRS ROYCE. SYDNEY N. S. W. 		STEEL. Rivet connections Timber Floor	CYLINDERS. 16Ft Diam.r 28Ft Centres.	L. 403, 367
MESSRS HANDYSIDE AND Co DERBY (DESIGN Nº 2) 		STEEL. Rivet connections Plate Floor. Wind Fence	CYLINDERS. 15Ft Diam.r 28Ft Centres	L. 435, 000
MESSRS ARROL BROS. GLASGOW. (DESIGN Nº 2.) 		STEEL. Rivet connections. Plate Floor. Wind Fence.	CYLINDERS. 15Ft Diam.r 40Ft Centres.	L. 439, 847

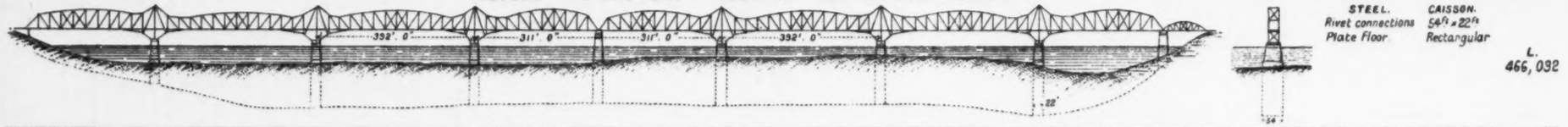
STEEL. Rivet connections. Plate Floor. Wind Fence.
CYLINDERS. 18ft Diamr. 40ft Centres.
L. 439, 847

MESSRS HANDYSIDE AND Co DERBY. (DESIGN No 1.)



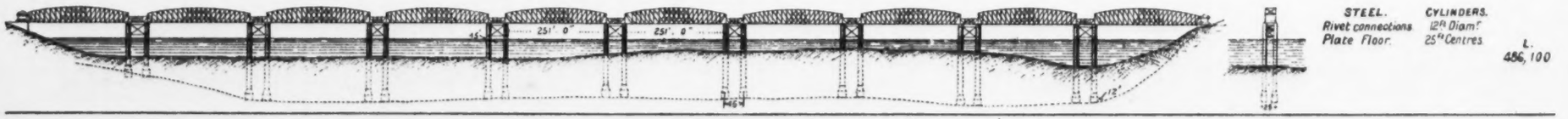
STEEL. Rivet connections. Plate Floor. Wind Fence.
CYLINDERS. 15ft Diamr. 28ft Centres.
L. 456, 000

MESSRS REICHENBACH GODFREY AND JONES LONDON.



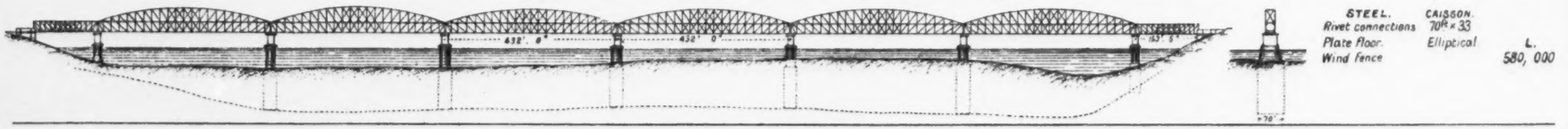
STEEL. Rivet connections. Plate Floor.
CAISSON. 54ft x 22ft Rectangular.
L. 466, 032

JOHN DIXON LONDON



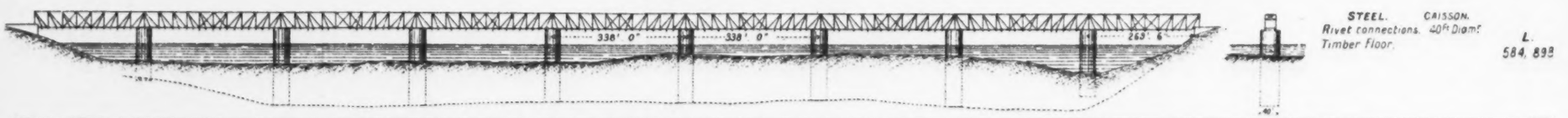
STEEL. Rivet connections. Plate Floor.
CYLINDERS. 12ft Diamr. 25ft Centres.
L. 486, 100

MESSRS ARROL BROS. GLASGOW (DESIGN No 1)



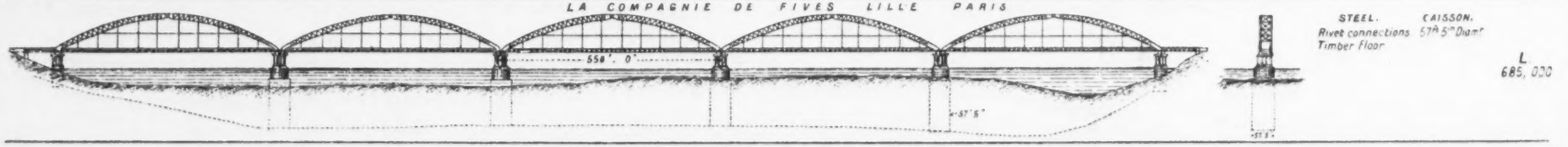
STEEL. Rivet connections. Plate Floor. Wind Fence.
CAISSON. 70ft x 33 Elliptical.
L. 580, 000

RICHARD PARKINSON LONDON.



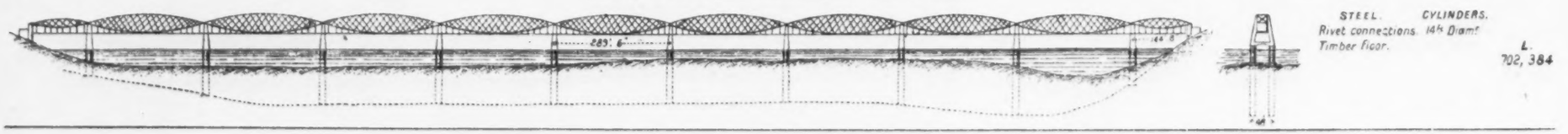
STEEL. Rivet connections. Timber Floor.
CAISSON. 40ft Diamr.
L. 584, 898

LA COMPAGNIE DE FIVES LILLE PARIS



STEEL. Rivet connections. Timber Floor.
CAISSON. 57ft 5in Diamr.
L. 685, 000

DAVID MUNROE MELBOURNE. VICTORIA.



STEEL. Rivet connections. Timber Floor.
CYLINDERS. 14ft Diamr.
L. 702, 384

C. M. BALTEN has been appointed Chief Engineer of the newly acquired Virginia Midland division of the Richmond & Danville R. R. R. D. WADE is Superintendent of motive power, and ROBT. ANDREWS remains as Superintendent.

We are pleased to congratulate City Engineer GEO. H. BENZENBERG of Milwaukee on his election as President of the Board of Public Works of that city. The nearer our American cities can get to the Providence, R. I., plan of placing a competent and trustworthy Civil Engineer at the head of the Public Works of each city, and holding him strictly responsible for the administration of his office, the better will such cities be served.

MR. EDWARD PRITCHARD, C. E., of London and Birmingham, England, and Mr. H. M. MORRISON, of Glasgow, Scotland, contractor, were visitors at the meeting of the American Society of Civil Engineers on Wednesday evening. These gentlemen are specially interested in "tramways," and are in this country for the purpose of studying the systems of Cable Roads now in operation here. They will go as far west as San Francisco. Their address in this city is the Brunswick Hotel.

HENRY H. RICHARDSON, the eminent architect, died at his residence in Brookline, Mass., April 28th. Mr. Richardson was born in New Orleans, La., about forty-eight years ago, and at the time of his death was at the head of the profession in this country. He designed Trinity Church and many other notable buildings in Providence, R. I., Sever Hall, High School and Austin Hall at Harvard College. He was consulting architect of the Albany Capitol, and at the time of his death was engaged on the magnificent new Court House in Pittsburg, Pa. Few men in his calling had such a widespread practice, and evidences of his skill can be found all over the country.

LYMAN. E. COOLEY—formerly a Professor of Civil Engineering in an Illinois college, assistant editor ENGINEERING NEWS, and later editor of the *American Engineer*; Engineer-in-charge of Missouri River Improvements under the direction of the U. S. Engineer department of St. Louis, and very recently the Engineer member of the Citizens Association committee to report on the "Drainage and Water Supply of Chicago" has been appointed hydrographic engineer to assist Mr. Rudolph Hering in his study of the drainage and water supply problem of Chicago. MR. COOLEY'S specialty has been hydrography, and we think that MR. HERING has secured in him a very valuable assistant.

Charles S. Cross, Civil Engineer.

For many years we had in our library a copy of Cross' "Engineer's Field Book," and from time to time we had applications for copies of the book. Engineers who had used the book were enthusiastic in commendation of it and its author, until at last we reprinted it in cheap form, and from an intimate friend of the author, now in the office of the N. Y. C. & H. R. R. Co., we obtained the following sketch of his professional career, which we consider of sufficient interest to warrant its publication:

CHARLES S. CROSS graduated from the Rensselaer Polytechnic Institute, Troy, in 1838. He was employed on the Genesee Valley canal during its construction. He had charge of a party on location and construction of the Saratoga and Washington R. R. (now Rensselaer and Saratoga R. R.) from Saratoga to Whitehall. Also on location and construction of Whitehall and Rutland R. R. in 1848. He had charge of a party on construction of the Harlem R. R., from Dover Plains to Chatham Four Corners; during this time he made sundry surveys for Messrs. Tilden & Phelps, from Chatham Four Corners north through Lebanon Springs to Bennington, Vermont.

On the completion of the Harlem extension he was directed by Messrs. Morris, Miller & Schuyler to form a party, subject to the orders of the late J. B. Sargent, to proceed to Chagres to examine and report upon the condition of the then unfinished work on the Panama R. R. This party left New York early in the year 1852, and returned to the city on board the steamer "United States," March 15th of the same year. Mr. Cross became very ill immediately after his return from Panama, and for many weeks he was confined to his room.

I believe it was sometime in 1852 that he had charge of a survey for a line of railroad from Ghent station to Troy.

In 1853-4 he was engaged in the survey and construction of the Flushing R. R. and during same time he had charge of surveys north or east of Huntington, L. I. He also had soundings made in the Harlem river, and located the site for the present railroad bridge over that stream for the Harlem Railroad Co.

From 1854 to 1857 he was engaged at sundry engineering projects, one of which was surveying and locating sites for light-houses along the coast from Sandy Hook to Barnegat. This work was done under the direction of Captain Dutton in the service of the United States; the office was at No. 3 Bowling Green. It was during this time that he made the computations, etc., for his excellent table-book.

Early in 1857 he formed a party and proceeded to the west where he surveyed and located the line of the St. Peter and St. Paul R. R. in Minnesota. During 1858-9 he was engaged in the construction of the Dundee dam on the Passaic river. In 1860-61, he was engineer in charge of location and construction of the extension of the Morris & Essex R. R. from Newark to Hoboken. In 1862 he was engaged on the location of the Rockaway railroad on Long Island. In 1863 he made further surveys from Ghent to Albany, and from Kent on the Housatonic R. R. to South Dover, on the Harlem R. R., and in 1864 he surveyed and located the line of the Lebanon Springs R. R., extending from Chatham Four Corners to Peterborough, Vt.

In 1869 he surveyed a line for a connecting R. R. from Philmont, on the Harlem, to Hudson, on the N. Y. C. & H. R. R. R.

Between 1868 and 1873, he surveyed, located and superintended the construction of the Spuyten Duyvil and Port Morris R. R.; also surveyed the line of the Portchester branch of the N. Y., N. H. & H. R. R., and partly superintended its construction.

In 1874-5 he surveyed and permanently established the lines of the property owned by the New York and Harlem R. R. Co. in what is generally known as the "annexed district," viz.: the 23rd and 24th Wards of the City of New York.

Mr. Cross was a man of great ability as an engineer. He had few superiors in his profession. His extreme diffidence and modesty kept him in the back ground. Every one who knew him loved him; and many there are who owe their success in life as civil engineers to him as their teacher and gentle instructor. He was a man of few words, but the words which he uttered were those of immaculate truth. He was the soul of honor, and the man who offered, or attempted to offer him a bribe, became his aversion ever after.

We are informed that MR. CROSS died in 1880 or 1881 of cancer, in Brooklyn, N. Y.

Fortification and Ordnance.

(Special Telegram).

Armor Plate Trials in Italy.

The test trials made during the past month by the Italian government at Spezzia to see how the Gruson chilled cast-iron armor-plate would resist the projectiles of 100-ton guns, have given results very complimentary to the Gruson metal.

American Society of Civil Engineers.

At the regular meeting on Wednesday evening, Vice-President Rowland in the chair, with a large attendance of members and visitors, Secretary Bogart referred to the death of Capt. R. N. Bailey, of the U. S. Engineer Corps, and it was ordered that a memoir of the deceased member be prepared for publication: the Committee on Standard Time presented their Report which was accepted, and the Committee discharged; the Committee on Convention reported progress; the time of departure is changed to 10 A. M., June 23rd, leaving the Grand Central station, New York, immediately after the "Limited" Express and running on same time, arriving in Denver on Friday night or Saturday morning following.

The following were elected:

MEMBERS:—*Almon Byron Atwater*, formerly General Superintendent and Engineer Georgian Bay and Lake Erie Division Grand Trunk Railway, Chief Engineer Chicago and Grand Trunk Railway; now Superintendent Chicago and Grand Trunk Railway, Detroit, Grand Haven and Milwaukee Railway, Michigan Air Line Railway and Detroit and Port Huron Division Grand Trunk Railway, Detroit, Mich.; *Frederick Eaton*, Consulting Engineer, Los Angeles City Water Co., Los Angeles, Cal.; *Eugene Frederick Fuller*, (Eng. Dept. Univ. Tenn. 1880.) formerly City Engineer, Knoxville, Tenn., recently Principal Assistant Engineer Tenth Ave. Cable Road, New York City; now Chief Engineer Paducah Water Supply Co., Chief Engineer Vincennes Water Co., and Chief Engineer Denison City Water Co., Paducah, Ky.; *Albert Mather Smith*, formerly Superintendent Manhattan Gas Light Co., recently Chief Engineer of the same company; now Engineer in charge 18th Street Station, Consolidated Gas Company, New York City; *Charles Sooysmith*, (Rens. Pol. 1876.) formerly Principal Assistant Engineer and Inspector of Superstructure Missouri River Bridge at Glasgow, Mo.; Assistant Superintendent of Track, Atchison, Topeka and Santa Fé Railroad; now engaged in General Contracting and Engineering work, New York City; *Augustine Washington Wright*, formerly Chief Engineer, St. Louis and Toledo Air Line R. R.; Chief Engineer, Havana, Rantoul and Eastern Railway; now Chief Engineer and Superintendent of Track and Construction North Chicago City Railway, Chicago, Ill.

JUNIOR:—*John Jacob Hopper*, on Engineer Corps of the Department of Public Parks, New York City.

The paper on "English and American Railroads Compared," by Mr. E. B. Dorsey was discussed by Messrs. Bouscaren, Goodwin, Harris, Emery, Morison and White of the Society, and by Messrs. Pritchard, of Birmingham, Eng., Henney, of the N. Y., N. H. & H. R. R., New Haven, and A. J. Stevens, of San Francisco.

There was the usual excellent collation served after adjournment, affording the opportunity for conversation and mutual acquaintance.

Connecticut Surveyors.

The ninth meeting of the Connecticut Association of Civil Engineers and Surveyors will be held at Hartford Conn., on Wednesday, May 26th, 1886.

It is especially requested that each member who intends to be present at the above meeting, notify C. H. Bunce of Hartford, Conn., that he may be able to make provisions for carriages for the afternoon programme.

PROGRAMME: 10 A. M.—Regular order of Business. Paper on "Water-Works of Southington, Conn.," by T. H. MCKENZIE. The object of this paper is to bring about a discussion of the merit of the various plans and methods in use for drawing water from both storage and distributing reservoirs, and the arrangement of gate houses, gates and pipes at the dams. Each member is requested to be able to make a statement of the arrangement of the gate houses, gates and pipes connected with the works in his town or city.

Paper on "Sewer Assessments," by F. W. WHITLOCK, of Waterbury, Conn.

Dinner at the United States Hotel. 2 P. M.—A visit to the Hartford Water-Works, by invitation of Henry W. Ayers, Engineer.

LITERATURE.

Proceedings of the Nebraska Association of Engineers and Surveyors at its First and Second Annual Meeting, held at Lincoln, March 26th and 27th, 1884, and January 13th and 14th, 1885.

There are seventy-three counties in the great State of Nebraska, with a total population of 500,000: there are forty towns and villages, with a population over 1,000: how many surveyors there are to the 76,855 square miles of its surface we do not know, but in the association referred to above there are thirty members distributed among nineteen different localities, and we can very safely presume them to be the "cream" of the profession in their State.

The association was organized at Lincoln in March 26th, 1884, "for the purpose of improving ourselves in the knowledge of our profession, and securing greater uniformity in our methods of practice." The neat 82 page pamphlet now before us is the record of the meetings of the two years of 1884 and 1885: no papers were read in 1884, but some very creditable ones were presented in 1885. The Committee on Engineering and Surveying reported that Nebraska had been a good field for surveyors and engineers during 1884; we presume it is still quite as good. In his address, President Andrew Rosewater, of Omaha, stated as follows:

"The utilization of the forces of nature and the elements in all their varied forms comes properly within the province of the engineer. The vastness of the field

renders it necessary to classify the labors into numerous branches—beginning with the surveyor who gathers the data and outlines the ground work. The town, before it can be judiciously improved, must be properly surveyed. The base lines must be definite and correct. A conflict in location involves doubts, delays and embarrassment with scarcely a limit to their evil results. Errors in distances imply errors in grades, and errors in grades involve errors in computation of dimensions and capacities in design.

"In a country like ours, subject to rapid development, towns have sprung up in an instant, as it were, and the surveys of their grounds and avenues have been hurriedly and carelessly done. The labors and value of carefully surveying were under-estimated, and now the day of reckoning has come with its endless disputes, litigations and delays. To prevent the recurrence of such work, to correct the errors of the past, to counsel and gain from one another the wisdom of each special experience, this, like similar organizations elsewhere, ha o been formed."

The following papers were read: "The Survey of a Section," by G. A. KILPATRICK; "Street Improvements in the City of Omaha," by A. J. GROVER; "What is a Surveyor and What Constitutes his Duties," by C. H. HOWES; "Riparian Rights," by GEORGE SMITH; "The Sewerage System of Omaha," by GEO. W. TILLSON; "The Well for the Water Supply of the City of Lincoln, Nebraska," by J. P. WALTON; Rulings of the Supreme Court of the State of Nebraska on Taxation, Street Grades, Plats, Boundaries and Corners, Riparian Rights and Drainage. The meeting of the Third Annual Convention, held January 18th and 19th, 1886, was reported in ENGINEERING NEWS, page 76 *ante*.

Among the handsomest and most complete of new illustrated machinery catalogues is the latest issue of the Rand Drill Company of this city, a large octavo pamphlet of 128 pages, devoted mainly to demonstrating the superior methods of the Rock Drills, Air Compressors, Mining Machinery and Miscellaneous Manufactures of this well known Company, but yet containing much information on the subjects of mining, tunneling, blasting and the use of the machinery adapted to these operations in engineering. There are many pages of tables and much "useful information" on boilers and chimneys; sizes and construction of chimneys; power of belting and gearing and shafting, etc. etc., in reality making a handy reference book, for an engineer, in addition to giving the illustrations, sizes, qualities and other information about the Company's manufactures referred to above. The excellent illustrated description of the Flood Rock explosion, contributed by Lieut. Derby to the *Sanitary Engineer* is reprinted, with handsome tinted reproductions of photographic views before, during and after, the explosion, and an interesting description of the New Croton Aqueduct giving the most important of the details, along with five full page tinted illustrations of drilling machinery and views of work on the Aqueduct. The Catalogue is for free distribution and can be had by addressing the Rand Drill Co. 23 Park Place, New York City.

Contractors for Pile Driving, Railroad Construction, Bridge Building and for all work involving general hoisting, will find in the new catalogue of the Lidgerwood Manufacturing Co., an illustrated description of such machinery as cannot fail to satisfy their most special or particular needs. Hoisting engines of every size and description with every detail of working efficiency tabulated are shown, also pile driving derricks, locomotives, boilers, and miscellaneous machinery relating to the specialty of hoisting.

Guild and Garrison, Steam Pump Works, Brooklyn, N. Y. have issued their handsome Annual Catalogue of Steam Pumping Machinery: it is very fully illustrated with pumping machinery for every use and can be had on application.

Address from the Executive Board of the Council of Engineering Societies on National Public Works.

CLEVELAND, O., May 1, 1886.

The time has come to define briefly the character and purpose of the permanent organization inaugurated by delegates from the several Engineering Societies of the United States, on March 31st and April 1st, 1886.

The "Council of Engineering Societies on National Public Works" is virtually a Central Committee of the several Engineering Societies of the country, organized for the purpose of promoting a change in legislative and administrative methods as applied to our Public Works, particularly to rivers and harbors. The members of the several society committees are members of this council, though each society is restricted to one vote. Associate members may be appointed by the Executive Board from those who will actively interest themselves in forwarding the objects of the council, especially in districts not favored with Engineering Societies. It is the policy of the council to enlist as large and active an interest as possible.

Since the preliminary convention of December 3d, 4th and 5th, 1885, those actively concerned in the movement have considered what course is wisest to follow. The general consensus of opinion favors deferring any presentation of the matter to Congress, until the engineers of the country generally, are fully advised as to the evils of present methods and are agreed as to the proper remedies. To this end, it is thought best to present fully the methods prevailing in this and in foreign countries, with recommendations of a plan for the discussion of the profession; the final results to be formulated and urged upon the consideration of Congress. This course is virtually adopted by the council.

The Executive Board will, as soon as possible, complete its arrangements for carrying out the policy outlined above. This will involve much labor and time on the part of a comparatively few individuals. Several months must elapse before this information can be placed before the profession. Meantime, the local committees can do much in diffusing a better knowledge of the spirit which actuates this movement, and in correcting errors and misapprehensions. The Executive Board with doubtless, from time to time, find occasion to assign special work to the local committees, and the important question of ways and means is always a prominent one for their consideration.

As to financial support, the Executive Board would renew the recommendations of Circular No. 9, of the Temporary Executive Board, which called for a contribution through each committee of not less than one dollar per capita in the societies represented. It is not believed that any less sum will be sufficient to meet the expenses of the council for the year, and each committee is especially urged to keep the question under advisement until the full quota is provided. Every engineer who may not be able to contribute through a Society Committee, is invited to send, direct to the treasurer of the council, such sum as he can afford. The success of the movements thus far, in securing the co-operation of the societies and of individuals, has been most gratifying. Engineers must not deceive themselves with the expectation that the objects of this movement are to be soon or readily accomplished. The question is one which involves too deeply the future policy of this Government, to be treated hastily, or without the most thorough consideration by our legislators. In this consideration, the profession must be prepared to speak as with one voice, not only as to the professional features of the problem, but as to its politico-economic phases as well.

The only objections which have thus far been urged, either by civil or military critics, have arisen from a misapprehension of the character and scope of this movement. It has been assumed to be based solely upon a question of class preferment, seeking the substitution of civilian for military domination in the conduct of our Public Works. Such a purpose, *per se*, would be justly deserving of contempt.

Since 1866, it has been the growing policy, and it may be now said to be the settled one of our Government to improve our harbors and waterways in the interests of commerce. Had methods of legislation, above reproach, been then adopted and continued to this time, and had an executive department, especially adapted to the requirements of the work, been constituted, the River and Harbor Bill, to-day, would be recognized by the people as the most beneficient of legislation effected by the general Government. The bill would appropriate not less than thirty to forty millions of dollars annually, the sum growing to fifty millions in the near future. By this time we should have had such a development of public improvements as to leave no doubt as to their great public utility.

These works would naturally make large demands upon the engineering profession, and would furnish employment of such a high order and of such permanence as to greatly promote the influence of the profession with the public at large, and to give it a status and prominence such as it has never yet attained in this country, though enjoyed abroad.

The influence on the labor market would also be most beneficent, affording a regulator to those social forces which now most threaten our peace, and meeting to a large extent the necessities of the otherwise unemployed. To bring about these results by a well-devised system of Public Works is entirely feasible, while in the benefits to be derived, all classes of citizens may share, not only in the present generation, but in all to follow.

The evils attending on the inception of and the appropriation for the various schemes and projects in the River and Harbor Bill are too well understood to need comment. They are matters which many thoughtful and disinterested congressmen are seeking to remedy. The evils attending the administration are to a certain extent the outcome of legislative practices, but at the same time they are in part due to a system not adapted to the purposes in view, and which, from the nature of things, can never give satisfactory results. As a consequence the River and Harbor Bill has fallen into disrepute, and its provisions are often looked upon by an intelligent public with well deserved suspicion.

These evils have been discussed to a limited extent only by engineers, but they will doubtless be given full consideration in future. It is at least apparent that neither the legislative nor administrative defects can be considered or legislated for, independently. The remedy for one must be in large part the remedy for both. What this remedy should be is the concern of this council.

In this view the question finds its broadest base in the public welfare. It is assumed from the start that whatever organization for the conduct of Public Works is provided, will be civil in its character, as it would seem to be contrary to human experience to constitute a military department for a purely civil work. But whether the individual talent utilized in this new organization be military or naval or civil is of little consequence so long as it takes its place in the organization on the basis of fitness. A new organization under a normal system of appropriation would certainly avail itself of all the experience now in service.

In conclusion, it may be well to say that while the question before us is one of moment to the welfare of our country and of our profession, it in no sense involves the superiority of one class over another; it does not necessarily relegate any set of men to less congenial duty. It may level, it may shift; it may produce individual hardships, but in the metamorphosis, the condition of those most immediately affected, must, as a whole be improved. In any event, it is not proposed to urge a change until it is clearly apparent that a definite and better system as a substitute for the present methods is provided.

Whatever success may attend our efforts in this direction must be achieved through the cordial and material support of the Engineers of America.

For the Executive Board,

L. E. COOLEY, President.

JOHN EISENMANN, Secretary.

WATER

"A western gentleman will exchange his house and furniture for a rowboat."—*The Judge.*

WORK is progressing rapidly on the water-works at Crawfordsville and Vincennes, Ind.

SPRINGFIELD, O., is agitating for an increased water supply.

A NEW reservoir is to be built on Meredith street, Davenport, N. Y. Address, M. L. Cleveland.

THE contract has been let for the erection of water works at Durham, N. C., to cost about $100,000.

NEW water works will be built at Martin's Ferry. Geo. Hornung, superintendent, Cincinnati.

MACON, Ga., April 25.—At last the work of boring the artesian well at the park has been commenced.

PHENIX, R. I. Work is being pushed on the pipe laying for the Pawtuxet Valley water-works.

THE Wilmington Gas Light Co., Wilmington, N. C., are preparing to renew and enlarge their plant.

THE Hiesler electric light system will be introduced at Ionia, Mich., about June 1.

THE Langhorne, Pa. Spring Water Company, has been incorporated. Capital stock, $20,000. Treasurer Henry W. Watson.

A BILL has been drawn up to permit the fire district of Turner's Falls, Mass., to lay water pipes in the town.

SUMTER, S. C., will probably have water works. The property holders favor the project and the Town Council proposes to engage an engineer to make plans and estimates.

COLUMBUS, Neb., April 28.—The City Council at its regular meeting this evening rejected all bids for the erection of water works, and will readvertise for new bids.

THE Finance Committee of Sharpsburg, Pa., advertise $60,000 5 per cent. water bonds for sale. Sealed bids will be received till May 12.

THE St. Mary's Falls Water Power Company, Sault Ste. Marie, Mich., has been incorporated. Capital stock, $1,000,000. President, George W. Brown.

CLARINDA, Io., contemplates putting in water-works. For particulars address the Mayor, Mr. Raymond Loranz.

THE Minneapolis, Minn., water department, has removed the last of the old Lowry hydrants and substituted post hydrants. The latter variety of hydrants will also be substituted in place of the flush hydrants.

BIDS for water-works to cost $30,000, at York, Neb., will be opened on the 26th. Hastings, Neb., is preparing bids to be advertised. Specifications of the entire work can be seen in this office, or they can be had by addressing the consulting engineer of both the above works, A. A. Richardson, C. E., Lincoln, Neb.

THE following persons have been elected officers of the Mount Vernon, N. Y., Water Company: President, F. Hopkinson Smith; Vice-President, George B. Inman; Secretary, Edson Lewis; Treasurer, David C. Curtis; Superintendent, William E. Allen. The company has a large gang of men at work laying the pipe through the streets, and by August next expects to be able to begin furnishing water.

CLEVELAND, O.—Messrs. Sutton & Paine, of the Water-works Board, accompanied by Superintendent Whitelaw and Secretary Madison, are taking a trip through the east, inspecting the water-works departments of various cities. It is proposed on their return to establish a commission, composed of Superintendent Whitelaw, City Civil Engineer Force, Health Officer Ashmun, and Sewer Inspector Smith, to examine applicants for sewer and plumbing permits. The Mayor believes such a commission will correct a steadily growing evil.

CHESTER, PA., April 29.—A company composed of local and outside capitalists has been granted charters to supply many of the townships in Delaware county with water. The plant, as proposed, will be immense. A spot has been selected for a reservoir on one of the highest spots in the county, and the force will be sufficient to reach every township. Should the scheme as projected be carried out the pipes will reach every township in the county, and it will require $500,000 to complete it.

SONG OF SIX LITTLE MEN.—Under this head the Syracuse *Standard* has cleverly adapted the following from the Mikado. It very pointedly hits off the six gentlemen mentioned as commissioners of water-works in the bill which was voted on by the people of Syracuse recently, and which, if carried, permitted the commissioners to build water-works and bond the city for their construction. The song is as follows:

Chorus of Water Commissioners named in the bill:

Six little men with plans are we,
To build a reservoir—don't you see,
Filled to the brim for you and me.

All—

Six little men with plans!

Mr. Duguid—Cardiff is the source of it.
Mr. Miller—Nobody cares if it's not fit,
Mr. Kirkpatrick—Water's as pure as Holy Writ!

All—

Six little men with plans!

The people—

Six little men with plans to carry,
Clothed with powers discretionary,
Who have for the people, confectionary,

All—

Six little men with plans!

Mr. Barnes—One little man is o'er the sea.
Mr. Kearney—Five little men might as well be,
Mr. Schlosser—On this proposition all agree,

All—

Six little men with plans!

Mr. Crouse—From six little men take one away,
Mr. Stevens—Five little men remain and they—
The people—Will be knocked out of sight election day!

All—

Six little men with plans!

The people—

Six little men with their plans awry,
A great big dam knocked into pi,
A great big dam—that's profane—Oh! my!
Six little men with plans!

The bill was lost.

IT is believed that Augusta, Me., at the meeting on the 10th inst. will accept the proposition of the Augusta Water Company as given in our issue of last week.

PUBLIC WORKS OF OMAHA.—The public work of the city of Omaha, Neb., for the year 1885, as summarized by the City Engineer, Mr. Andrew Rosewater, is as follows:

Grading, 164,782 cubic yards	$ 29,768.97
Average, 18c. per yard	
Curbing and guttering	32,614.10
Paving, 56,531 square yards	170,765.97
Sewers, 4,326 lineal feet	6,351.83
Sidewalks	5,175.75
Hanscom Park water service	551.23
Engineering supplies, salaries, etc	11,946.86
Total	$257,174.69

These results added to summaries of paving, curbing and sewer work heretofore done, show the following for the permanent public works of the city at this date:

Curbing set, twenty miles.

Sewers laid, 116,366 lineal feet, or very nearly twenty-two miles.

Paved streets, mostly 60 feet between curbs, aggregating 320,107 square yards, nine and one-half miles.

Paved alleys, 20 feet wide, 15,262 square yards, one and three-fourth miles.

Total paved area 335,369 square yards, eleven and one-fourth miles.

These improvements aggregate in cost as follows:

Curbing	$ 102,000
Sewers	466,768
Paving	1,000,000
Total	$1,568,768

The work for the current year, although already largely designed, is so extensive in character and covers such a large range of territory, that the force of the department will have to be enlarged within two months for the balance of the season, as all the work will require laying out and supervision within a working period of less than six months. The work will be about as follows:

Grading (one-half being city's share)	$120,000
Paving	450,000
Sewers	200,000
Curbs	60,000
Viaducts	120,000
Total	$950,000

This estimate may seem large, but the expenditures are more liable to exceed $1,000,000 than to fall below the figures of the summary.

ST. LOUIS' PUBLIC WORKS.—During the past year 8.53 miles of granite pavement were laid and 1.28 miles of asphalt pavement, at respective costs of $631,730.48 and $77,458.94, and there are now under contract 9.14 miles of granite and 1.32 miles of wood pavement. The Street Commissioner recommends the reconstruction of the streets along the route of the cable railway. The total expenses of the Street Department were $842,295.45. The masonry of the approach to the Grand avenue bridge has been completed and the foundations of the anchor piers commenced. The water works are reported to be in first class condition, and the high service pumping capacity and distributing mains and pipes equal to all probable requirements for years to come. The Water Commissioner recommends the removal of the low service engines from Bissell's Point to the Chain of Rocks, and the construction of a conduit from the latter point to the present settling basins, a distance of about seven miles. This work will necessitate an expenditure of about $3,000,000. The Commissioner says that the daily capacity of the low service engines should not be placed above 30,000,000 gallons, while the capacity of the high service engines and the district mains is 50,000,000 gallons per day. The daily average consumption during the past year was 26,900,000 gallons. The total expenses for the Water Commissioner's Department have been $547,468.36, of which $219,475.52 has been applied to the extension of distribution mains, $94,192.16 to the extension of the works and $233,800.68 to maintenance. The cost of pumping has been $13 75.5 per 1,000,000 gallons, as against $16 91.6 for the previous year, or as against $16 79.1, the average cost for the previous six years, a most excellent exhibit. The distribution system has been increased by 22 miles of pipe and 226 fire plugs. The total amount expended for public sewer work was $80,096.35. Permits for connections were issued to the number of 2,215, an increase of 35.6 per cent over the preceding year, which increase was largely due to the enforcement of sanitary measures by the Board of Health. The additional work which the supervision of the construction of vaults, etc., entails upon the department will necessitate the employment of additional help. The construction of the Vandeventer district sewer in the new limits, which is now ordered, will be one of the most important public works of the season. The Board of Public Improvements advises against hasty legislation upon electric street lighting, recommends a new system of water filtering and the abandonment of limestone for macadam paving, and outlines principles for future granting of franchises to street railroads.

GALESBURG, ILL.—The engineers have surveyed the valleys east of the city, and report two that promise capacity sufficient to impound water enough to last the year around. One of these has a storage capacity of 70,000,000 gallons. The other is reported to be much larger. The engineers declare impounding the only reliable means of obtaining a supply. They have no faith in wells; the geological formation of the country being against the well plan.

THE St. Paul Water-Works Company is endeavoring to run Rice creek, ten miles north of Stillwater, into Lake Phalen to increase the supply. Surveyors are at work along the creek, near Centreville station. The changing of the course will be a very expensive job, but this creek alone would supply a city of 300,000 inhabitants. This, together with Lake Phalen and Lake Vadnais, on which St. Paul depends for her water, would give the city an immense supply. Rice creek is tributary to the Mississippi river, is about 30 feet wide and is very deep. The water is clear as crystal, and is said to be the finest in the state.

THOMAS SHANAHAN, contractor, has had in his employ for a month or more, seventy men engaged in laying the pipes of the Portland Water Company in Deering, Me. He has paid them $1.50 a day. Saturday morning last they all quit work. They made no demand for higher pay, and Saturday forenoon, Mr Shanahan had not seen any of their number. He understood from outside persons that they want $1.75 per day. The Portland Water Company have in their own direct employ about 130 men, engaged in the same work in another part of the town. These all receive $1.50 a day, and they are satisfied with their wages so far as known.

AT a meeting of the common council of Plainfield, N. J., on Monday evening, a communication from Samuel P. Bullock & Co., of New York, with reference to furnishing the city with water-works, was partly read, and on motion of Mr. Dumont referred to the Fire, Water and Lamps Committee. Two petitions were read from property owners along Broadway asking Council to adopt an ordinance for paving said thoroughfare with crushed stone, at a cost not to exceed 12½ cents per lineal foot, property-owners to pay their share of the expense. Mr. Bowers stated that he had the contract for lighting the city by electricity; also the bond of the Thompson-Houston Company. He recommended that the bond be received, and that the Mayor be instructed to sign the contract. So ordered, all voting aye.

THE Paola, Kansas, water-works are completed, and have been accepted by the town. They are owned by the Paola Water Company. The Mayor and Council were so well pleased with the official test made on the 27th ult., that they "RESOLVED, that we tender our thanks to Col. S. H. Locket, Chief Engineer and Superintendent of Construction, and E. J. Snow, General Manager of the Water Company, for the honorable, skillful and efficient manner in which they have discharged their duties in the construction of the water-works; and RESOLVED, that the thanks of the city of Paola are hereby tendered to the Paola Water Company and the contractors, Messrs. Comegys and Lewis of New York, for the very superior system of works they have given us, and that we take pleasure in recognizing the fact that our city has water-works which will compare favorably with any works in the country, and which in design, excellence of material and construction could not well be surpassed."

ELECTRIC LIGHT BIDS.—The bids for lighting Galesburg, Ill., are as follows, the city having asked the cost of 65, 85 and 100 light plants respectively:

Brooklyn Electric Light Company—

65 single arc lamp plant	$14,530
65 double carbon lamp plant	15,180
85 single arc lamp plant	15,080
85 double carbon lamp plant	16 080
100 single arc lamp plant	16,470
100 double carbon lamp plant	17,470

Thomson-Houston Electric Light Company—

65 single arc lamp plant	$15,463.75
65 double service lamp plant	16,000.00
85 single arc lamp plant	16,899.00
85 double service lamp plant	17,600.00
100 single arc lamp plant	19,046.00
100 double service lamp plant	19,871.00

Brush Electric Light Company—

65 single arc lamp plant	$11,099.75
65 double lamp plant	11,489.75
85 single arc lamp plant	14,514.60
85 double arc lamp plant	15,034.60
100 single arc lamp plant	17,076.00
100 double arc lamp plant	17,676.00

Fort Wayne Jenney Electric Light Co.—

65 light plant	$13,445.00
85 light plant	15,725.00
100 light plant	17,485.00

Sperry Electric Light, Motor & Car Brake Co.—

60 arc light system	$7,000.00
85 arc light system	9 000.00

All of the bids were referred to the Street Lighting Committee.

No. 16. Water Pressure in Mains of Various Cities.

COMPILED BY J. J. R. CROES. FROM SPECIAL RETURNS, JAN., 1886.

Town and State.	Topography.	Difference of level in town.	In Business District.		
			Day Pressure.	Night Pressure.	Fire Pressure
		feet.	lbs.	lbs.	lbs.
Adams, N. Y.	level.	very slight.	45	45	45 to 150
Columbus, Miss.	level.	25	20	20	20 to 25
Holland, Mich.	level.	0	35 to 40	30 to 35	80 to 120
Hollister, Cal.	level.	0	47	47	47
Irvington, N. Y.	hilly.	0	180 to 200	180 to 200	180 to 200
Kent, Conn.	level.	0	65	65	65
Laredo, Tex.	level.	0	20	20	90 to 125
Lexington, Ky.	level.	2	60	65	100
McKeesport, Pa.	undulating.	126	115	115.4	115
Marlborough, Mass.	hilly.	———	90	92 to 93	———
Melrose, Mass.	hilly.	30 to 70	32	38	32 to 38
New London, Conn.	hilly.	90	50 to 60	60 to 70	———
Norristown, Pa.	hilly.	100	45 to 80	———	———
Northampton, Mass.	sloping.	———	80	90	80 to 100
Peekskill, N. Y.	undulating.	125	110	110	163
Pittsfield, Mass.	hilly.	———	40	55	40
Richmond, Ind.	level.	20	68	68	200
St. Thomas, Ont.	level.	0	45	45	80 to 85
Salamanca, N. Y.	level.	———	75	75	75
Salem, N. J.	level.	0	30	30	90 to 100
Tiffin, Ohio.	level.	30	45	38 to 40	90 to 130
Trinidad, Col.	hilly.	10 to 100	125	125	125 to 135
Watertown, Mass.	hilly.	30	85 to 90	85 to 90	85 to 90
West Bay City, Mich	level.	20	35 to 50	35 to 50	80 to 150
Wooster, Ohio.	hilly.	100	50	50	50

AN electric light plant will be erected at Charlotte, N. C., by Mr. Robinson. Work is to be commenced soon.

THOMAS G. EATON, previously reported as having the contract to erect gas works at Sanford, Fla., will build similar works at Gainsville, Fla. They are to be completed by March, 1887.

STAFFORD SPRINGS, CONN.—The water company has recently purchased certain rights of both water and land, and will furnish the village with an excellent water supply.

HUNTINGTON, IND. has purchased a Jenney electric light plant, which was lit up recently for the first time, and worked very successfully. Huntington is the first town to purchase a plant outright.

ATHENS, GA. There is a strong sentiment in favor of the city buying the water works when they are sold. The property can be bought for about $40,000, and will pay a handsome dividend, besides reducing the price of water.

GREENFIELD, MASS. The water commissioners elected are J.H. Sanderson, Anson Withey and David Hunter. The new water works are now complete and have cost $60,000 in addition to the old works.

THE New Orleans Draining and Paving Association has been incorporated by Edward Fenner, J. H. Keller, W. H. Watkins and others. Its object is to erect works for the purpose of draining, sewering, grading, flushing and paving that city.

SEGUIN, TEX., April 25.—A company has been formed to place a $30,000 system of water-works on the combined stand-pipe and pressure system. They will have a capacity of 1,600,000 gallons a day. Four miles of pipe have been secured and all contracts been let. The water is to be brought from the Guadalupe river, one half mile away.

THE Cohasset, Mass., Water Company has elected the following officers: Charles A. Welch, President; James H. Bouve, Secretary and Treasurer; Charles A. Gross, Charles F. Tilden, Charles A. Bates, Charles A. Welch, Waldo Higginson, Ezekiel B. Studley, James H. Bouve, Directors. Work has been commenced driving the artesian wells.

A PROJECT is now being agitated looking to the drainage of the large wet district lying southeast of Sumterville, Fla. The territory embraces over 100 000 acres of land, a large portion of which is now covered with water, and useless, which by being drained would be placed among the most productive and valuable lands in the county. It is claimed that this can be accomplished by digging a ditch four miles in length, nine feet wide and three feet deep, thus conducting the water from the lake district to the branch creek, east of the town. There is a natural drainage in this direction, with a fall of from fifteen to twenty feet in the four miles. The land affected by this drainage extends to and around Centre hill. The organization of a stock company having for its object the accomplishment of this work, is talked of.

ST. JOSEPH, MO.—A farmer living near the lower end of Lake Contrary, five miles south of this city, has considerable marshy ground bordering on the water. A short time ago he concluded to improve his land and dug a drain 8 feet deep and 10 feet wide from the lake edge to a small creek near by. The lake was soon successfully lowered over 2 feet. The lake is ten miles long and has an average width of a third of a mile. It is a popular pleasure resort and a dozen fine hotels line its banks. Movements are now on foot to investigate the matter. The people at the Lake House noticed the water had been receding. This led to an investigation. Already the boat-house and bath-houses are high and dry.

DELAWARE, O., WATER-WORKS.—Mr. J. D. Cook, waterworks engineer, has submitted his report to the City Council. As source of supply he suggests Greenwood lake as a point where water is easily attainable and abundant in supply. By placing pumping plant at the confluence of the Olentangy river with Vergon run, water from the river could be used as an auxiliary supply, or if subterranean water should be deemed preferable it would probably be as accessible at that point as anywhere. The water may be rendered more desirable in quality and copious in quantity by the construction of a dam across the valley of the run near the river, to store the overflow and clarify the water, sediment being easily and frequently removed by underdrainage into the river. By the raising of the present dam from 1 to 3 feet an immense additional capacity could be secured. The pumping machinery to be in duplicate, or in two engines and pumps, with an aggregate pumping capacity at slow, safe velocity, to pump four million gallons of water per hour. The report recommends the direct pressure system, as the topography of the city precludes the possibility of an elevated reservoir, while a metallic standpipe would involve an unwarrantable expense. The pipe, valve and hydrant distribution is estimated as follows: 16-inch pipe, 3,659 feet; 12-inch pipe, 5,420 feet; 10-inch pipe, 4,090 feet; 8-inch pipe, 11,620 feet; 6-inch pipe, 61,630 feet; 6-inch hydrant branches, 1,004 feet; 4-inch pipe, 12,400 feet; total length of pipe 100,174 feet, or 18 96-100 miles. Number of 16-inch valves, 2; 12-inch, 5; 10 inch, 4; 8-inch, 15; 6-inch, 97; 4-inch, 31; total number of valves, 154. Hydrants, 167.

ESTIMATES.

Estimate No. 1, Location "A."

99,170 lineal feet of pipe, 2,077 tons including laying	$ 80,052.00
41 tons special castings @ $60	2 460 00
154 valves	3,000.00
167 hydrants @ $20	9,680.00
Building stack and connections	8,000.00
Pumping machinery, boilers and fixtures	21,000.00
Dam, conduit, well and connection	23,600.00
Real estate, engineering, inspection and incidentals	10,208.00
Total	$155,000.00

Estimate No. 2, Location "B."

Item No. 1 as per estimate No. 1	$121,192.00
Item No. 2, dam, wells, conduit and connections	17,150.00
Item No. 3, real estate, engineering, etc	9,658 00
Total	$148,000.00

Estimate No. 3, Location "C."

Item No. 1 as per estimate No. 1	$121,192.00
Item No. 2, supply well, river connection, conduit and connections	4,150.00
Item No. 3 as per estimate No. 2	9,658.00
Total	$130,000.00

NEWS OF THE WEEK.

CONTRACTING.

Grading.—E. C. Corbitt, of Macon, has a contract for grading the Savannah, Dublin & Western Short Line Railroad, and has commenced work west of Savannah, Ga.

Street Cleaning.—M. J. O'Reilly has been awarded the street cleaning contract for the district south of 14th street, and east of Broadway for three years at $204,900 per year.

Sea Wall.—CHICAGO, April 28.—The Lincoln Park commissioners have decided to construct a sea-wall near the shore in Lake Michigan to protect the lake shore drive in the north division of the city nearly ruined by recent storms. The proposed sea-wall has been approved by United States engineers.

Dock.—Winston Bros. have let sub-contracts on their contract for the Manitoba docks at West Superior, Minn. Peyton, Kimball & Barber will furnish about 1,000,000 feet of lumber and G. C. Greenwood will furnish the drift bolts, etc. Their contract will amount to about twenty-five tons of ironwork.

The Rutland & Montreal R. R. Company (formerly the Lebanon Springs R. R.) has closed contracts for steel rails, iron bridges, new equipment and earthwork for filling for that part of the line which was originally built with piling and trestle work.

Colorado Projects.—It is reported that Denver capitalists intend to erect large reduction works at the Needles on the Colorado river in San Bernardino Co., California. It is also said that at the same time a railroad will be built beginning at the Needles and running to Providence, thence to Soda lake, and continuing further north to other mining districts.

Bridges and Masonry—At Rome, Ga., one bridge 300 feet span, or two equal spans aggregating 300 feet; the other bridge 260 feet span or two equal spans aggregating 260 feet. For both bridges, roadway 18 feet, live load 70 pounds per square foot for one span or 80 pounds for two spans. Factor of safety 4. Masonry will consist of 4 abutments, and, if short spans are adopted 2 piers. Board of Commissioners of Roads and Revenue of Floyd county, Rome, Ga. June 7.

Chimney Stack.—The Board of Water Commissioners, Wilmington, Del., has received the following bids for a foundation and stack for the new pump and engine at City Mill station:

	Stack.	Foundation.
Charles W. Salloway	$8,923	$———
Patrick J. Duffy	6,123	4 924
Edge Moor Iron Company	5,600	———
Daniel McCurdy	5,850	4,550
B. F. Perkins	5,674	4,200

The Silver Hook Bridge.—Work has been begun on a new iron bridge on the Silver Hook road, Pawtuxet, R. I., which is to take the place of the wooden one destroyed by the flood. The contract for the iron work has been let to Dean & Westbrook, agents of the Phœnix Iron Works, Phœnixville, Pa. The roadway will be 20 feet wide, and in additional to this there is to be a sidewalk 5½ feet wide. The contract for the building of the abutments has been let to Reed & Co., of East Providence. They are to be built upon piles, driven 30 feet into the ground. The material used will be rough granite, faced on both the inside and outside, laid in Norton cement. The work is under the immediate superintendence of Mr. Joseph E. Latham, engineer, of Providence.

Dredging.—Proposals for dredging in Baltimore harbor, etc., were opened recently in the office of Major Hutton, engineer of the harbor board. Proposals were asked (1) for dredging 240,000 cubic yards from the harbor and channels generally; (2) 60,000 from the back basin and docks; (3) 70,000 cubic yards from the Spring Gardens, and (4) 30,000 cubic yards from the quarantine anchorage—about 400,000 cubic yards in all. The sum of $50 000 is appropriated for the three items of the work, and $15,000 especially for the Spring Gardens dredging. The amount of work is subject to increase or decrease from the estimates, so that it is done within the appropriation. There were eight bidders per cubic yard, as follows:

Canton Dredging Company, 1st, 13¾c; 2d, 16¾c; 3d, 14¼c; 4th, 12¾c.

Charles W. Nelson, Jr., 11c, 15c, 11c, 10c.

Thomas Trimble, 11c, 13c, 11c, 10c.

Ross & Sanford, 11c, 14c, 12c, 10½c.

Baltimore Dredging Company, 13c, 16c, 14c, 12½c.

Samuel P. Wilson, 9 8-10c, 14c, 9 8-10c, 9c.

J. seph V. Campbell, 2d, 20c; 3d, 18c; 4th, 17c.

L. J. Fobes, 13¾c, 20c, 14¾c, 12¾c.

The bidders were all Baltimore parties, as required by the new city ordinance.

Water Pipe.—The following bids were opened at the Department of Public Works, Wednesday, May 5, for furnishing cast-iron water pipe, branch pipes and special castings. Warren Foundry and Machine Co., 1,920 tons pipe, $25.16; 100 tons branches and castings, $48.37; total, $53,141.20; Camden Iron Works, $27.35, $48.60, total, $57,372. Contract awarded to the Warren Foundry and Machine Co.

Laying Water Mains.—The following bids were opened at the Department of Public Works, Wednesday, May 5.

Mulberry Street and Bowery.

	200 c. yds. Rock Ex'vation.	7,200 c. yds. Earth Ex'vation.	7,000 c. yds. Earth Filling.	10,500 lin. feet 12-in. Pipe.	1,500 lin. feet 6-in. Pipe.	17 12-in. Stop-cocks and Boxes.	5 6-inch Stop-cocks and Boxes.	42 double nozzle Hydrants	15 c. sds. Brick Masonry.	4,000 sq. yards Pavement.	800 lin. ft. Curb and Gutter.	Totals.
E. N. Lynch	2.50	.30	.15	.40	.25	10.00	10.00	10.00	15	.35	.10	$10,630
F. Thileman	3.00	.30	.15	.40	.20	10.00	5.00	10.00	10	.30	.10	10,355

Contract awarded to F. Thileman.

95th and 183rd Streets; 6th, 11th, Lexington, Sedgwick, Vanderbilt, Creston and Morris Avenues, Boulevard, Highbridge Road and Southern Boulevard.

	2,000 c. yrds. Rock Ex'vation.	14,000 c. yds. Earth Ex'vation.	13,200 c. yds. Earth Filling.	11,700 lin. ft. 12-inch Pipe.	18,000 lin. ft. 6-inch Pipe.	9 12-inch Stop-cocks and Boxes.	29 6-inch Stop-cocks and Boxes.	38 Hydrants.	5 c. yrds. Brick Masonry.	700 square yards Pavement.	500 lin. ft. Curb and Gutter.	Totals.
E. N. Lynch	2.50	.30	.15	.35	.23	8.00	7.00	8.00	10	.20	.05	$20,509
J. Cornwell, Jr.	2.50	.20	.10	.35	.25	6.00	5.00	5.00	2	.12	.02	17,908

Contract awarded to John Cornwell, Jr.

A. T. & S. F. R. R.—R. W. Sparr has a contract to build forty-two miles of railroad for the Leroy and Western Railroad, virtually the Atchison, Topeka and Santa Fé R. R. Co., from Mulvane Junction west. This company is now actually at work on eleven different lines of railroad in Kansas, the aggregate length of which is 450 miles.

Brick Paving.—Decatur, Ill., is having brick paving laid down. Haworth brick are used, a layer laid flat on 5 inches of packed sand and gravel, and a layer of the hard-burnt quality laid edgewise on top, resting on 2 inches of sand. The improvement is let by private contract and will not cost property owners more than $1.50 a square yard. John Grass is the contractor.

Contractor vs. C. P. R. R.—An action brought by contractor Lafferty against the Canadian Pacific Railway Company to recover the balance due on his contract on the Ross division has been settled out of court at Toronto, the company paying the contractor $6,900, the full amount of his claim with costs.

Street Paving.—The following are the highest and lowest bids for the street paving at Cincinnati, O.:

			Lowest.	*Highest.*
Bowlders	per	cubic yard	$1.50	$2.70
Curbs, 4-inch	"	lineal foot	.80	1.35
" 5-inch	"	" "	.80	1.48
" 6-inch	"	" "	.80	1.58
Curb, reset, 4-inch	"	" "	.05	.20
" " 5-inch	"	" "	.05	.20
" " 6-inch	"	" "	.05	.20
" " 8-inch	"	" "	.06	.20
Crossings	"	" "	.80	1.40
Grading	"	cubic yard	.10	.65
Granite	"	square yard	2.98	4.78
Limestone	"	cubic yard	1.30	2 10
Cement	"	" "	4.10	6.12½
Sand or gravel	"	" "	.60	1.90
Rolling	"	square yard	.02	.08

Sewer.—The bids for the Vandeventer avenue sewer, District No. 1, St. Louis, April 28th, were as follows:

Fruin Bambrick Construction Co	$283,652.05
Allen & Veiths	267,618.75
William Skrainka	264,550.30
August Heman	240,572.00
P. Brusstar & Co	247,527.70
G. Egermann	265,282.90
John Bambrick	260,788.00
George Prendergast	256,019.60

The following are the prices of the successful bid: Earth excavation, 30 cents per cubic yard; rock excavation, $1; rubble masonry, $3 per cubic yard; brick masonry, $7; pipe sewers, 6-inch, 50 cents; 9-inch, 50 cents; 12-inch, 80 cents per lineal foot; 15-inch, 90 cents; 18-inch, $1.25; junctions, 6-inch, 50 cents each; 9-inch, $1; 12-inch, $1.50; 15-inch, $1.50; 18-inch, $2; inlet stone, 70 cents per square foot; cast-iron, 3 cents per pound; wrought-iron, 5 cents; concrete in place $3 per cubic yard.

Proposals Open.—The following works are contemplated, and bids will be received up to the dates given:

Bridge.—Over Republican river at Edison, Neb.; five spans, 60 feet each; superstructure, combination bridge on foundation already constructed. C. H. Pierce, county clerk, Furnas county, Neb. May 10.

Rolling Stock.—Fifteen passenger cars. J. J. Burns, General Storekeeper, Union Pacific R. R., Omaha, Neb. May 10.

Flood Gates.—Three caissons. Louis Lesage, Superintendent of Water-works, Montreal. May 11.

Masonry and Iron Beams.—Kansas State House. Geo. Ropes, architect, Topeka, Kan. May 12.

Railroad.—Smith's Falls and Montreal extension of the Ontario & Quebec R. R.; 121 miles. W. G. Van Horne, Vice-President, Montreal. May 14.

Grading.—Savannah, Dublin & Western Short Line R. R., Lotts Creek to Dublin, 70 miles. President's office, 306 Stock Exchange place, Philadelphia, Pa.; and Chief Engineer's office, Savannah, Ga. May 14.

Buoys, Anchors, Etc.—Light House Inspector (3d District), Tompkinsville, N. Y. May 15.

Blast Furnace.—Bidders requested to examine site; work to begin by July 1. Sheffield Furnace Company, Sheffield, Colbert county, Ala. May 15.

Ironwork.—The public buildings at Lynchburg, Va. Supervising architect, Washington, D. C. May 17.

Building.—Chamber of Commerce. Board of Real Estate Managers, Cincinnati, O. May 17.

Freight House and Office.—At Atlanta, Ga. E. H. Barnes, Superintendent E. T., Va. & Ga. R. R., Atlanta, Ga. May 20.

Metal Protractors.—Bureau of Navigation, Navy Department, Washington, D. C. May 21.

Water-Works.—Fort Niagara, N. Y. Plans and specifications at Fort Niagara, and at Quartermaster's office, Governor's Island, N. Y. May 25.

Railroads, Bridges and Canals.

Pittsburg & Preston County R. R.—This line, which is a continuation of the Southwest R. R. from Fairchance, Pa., to Preston, W. Va., is to be built soon. Engineers will be placed in the field this season.

Unemployed Laborers Abroad.—BRUSSELS, May 5.—In the Chamber of Representatives to-day M. Beernaert, Premier and Minister of Finance, announced that a loan of $8,600,000 would be issued to provide work for unemployed artisans and laborers. The leaders of the Opposition promised to co-operate in the attempt to solve the labor difficulty.

Canadian Pacific Railway.—Advices from Victoria, British Columbia, state that the damage done in the mountain region was much more extensive last winter than reported. Several miles of track were carried away, some bridges destroyed, and the damage cannot be repaired before August.

The Missouri Central Bridge.—ALTON, ILL. April 28.—President George I. Post, of the Missouri Central Railroad Company, reached here to-day, accompanied by E. L. Corthell, the engineer who built the Chicago and Alton Railroad bridge at Louisiana, and who is to build the Missouri Central bridge at this point. The day was spent by the company in surveying the river to select the most suitable site for a bridge.

Windsor Locks Bridge.—Engineer C. E. Savage is making arrangements to repair the west abutment of the new bridge, which is badly cracked. Piles, 45 feet long, will be driven near the abutment, on which will rest a large iron girder, weighing several tons, which will be attached to the cables and to the bridge, and the whole end of the bridge will then be lifted by means of powerful levers. The cracked stones will then be removed and replaced with large hewn blocks. About 100 tons will be raised in this manner. The work will not prevent the passing of teams. About three weeks will be necessary to complete the work, at a cost of $2,000.

American & Mexican Pacific R. R.—Col. A. K. Owen, chief engineer of the Topolobampo Railroad, has gone to the city of Mexico to meet ex-Senator Windom. A large colony has been organized in the United States and these gentlemen have gone to President Diaz and Congress to ascertain what concession can be obtained. They claim to have $500,000 in cash, $1,000,000 in property and 2,000 colonists ready to go. Their destination is Gonzales City, the proposed terminus of the Topolobampo Railroad on the Pacific coast. The scheme is one of the largest of the kind yet undertaken.

The Shenango Valley Railroad Company was organized at Sharon, Pa., April 27, at a conference held between prominent Lake Shore & Michigan Southern officials and Shenango Valley iron manufacturers. The road will extend from the Ohio State line to Sharpsville. A charter will be applied for at once. The line will connect at one end with the Lake Shore & Michigan Southern R. R. and at the other with the Baltimore & Ohio R. R.

The Southern Pacific R. R. will build a line from Soledad to Bakersfield, which will give it a through route from San Francisco to Los Angeles. At present its trains enter San Francisco over the Central Pacific R. R. tracks.

Abilene & San Angelo R. R.—The surveying corps have finished the location of the line. They report the route as smooth and cheap to build upon, there being no large expense anywhere except in bridging the Colorado river. Grading will begin about the middle of May, and the road then finished with all possible speed.

The East Tennessee, Virginia & Georgia R. R. has commenced to change the line to standard gauge. The company will first change the gauge on all the branch lines before beginning on the main line. The gauge on the Selma division, from Selma to Meridian, a distance of 110 miles, has been changed.

The Dayton and Northern R. R. Co. has been incorporated with James O. Arnold, Orarge O. Oyler, W. W. Buchwalter, Arthur M. McComb, Horace A. Hubbard as incorporators. The purpose is to operate a railroad from Dayton to Delphos, O.

The Galveston, Sabine & St. Louis R. R. Co's directors have resolved to begin work as soon as possible on the extension of the road from Longview, Tex., northward to a connection with the Texas and St. Louis R. R., and from the present southern terminus southward to a connection with the Houston, East and West Texas R. R.

Blastings Operations on the Panama Canal.—M. de Lesseps, who has recently returned from a visit to the Panama Canal Works, personally assisted at the explosion of a mine in a hill of hard rock some thirty metres high, situated at Gamboa, near the middle of the isthmus. The hill barred the course of the canal, and it had to be removed. Last year about the same place a blast operation disengaged 20,000 cubic metres of material. On this occasion 30,000 cubic metres were broken up by the explosion. To avoid projecting the debris too far and damaging the works, the engineers employed as explosive a mixture of two parts of dynamite and one part of powder. The formula employed for the charge, as given by M. Bunau-Varilla, the engineer, was

$$C = R^3 \cdot 6\, G\, K$$

where C is the charge, R the radius of mean resistance, G a co-efficient of hardness varying from 1 m. to 2.50 m. (the value 2 m. being adopted), and K a constant = 0.18. The charge consisted of pockets of dynamite, the intervals between being filled with powder and grains of 0.0025 metres diameter. The space below the charge was filled with sandbags. The *bourrage* was executed in masonry. The length of the front of attack was 55 metres and three galleries were opened perpendicularly to it, each gallery being 1 square metre in section, and running 18 meters into the hill with chambers at the ends. The firing was arranged in such a way that the three fuzes were simultaneously fired by an electric current. All the conductors were inclosed in an iron pipe 0.026 metres in diameter, and running from the centre of the charge through the *bourrage* or filling. The explosion was completely successful and reflects much credit on the engineer, including M. Gaitier. Wicks were also installed in the galleries in order to insure the explosion, in case the electric fuses failed; but they were not required, as the explosion answered to the signal. M. Bunau-Varilla is a young engineer who has associated with him as director, M. Boyer, an engineer of the Ponts et Chaussées.—*Engineering.*

Chicago, Freeport & St. Paul R. R.—Construction bonds for the first fifty miles have been negotiated and work will soon be commenced between Freeport and Blanchardville, Ill.

The Atchison, Topeka & Santa Fe R. R. Co. has completed arrangements whereby it has assumed complete control of the California Southern R. R., which extends from Mojave to San Diego, Cal. The latter road was finished last fall.

Southern Pacific Branch R. R. Co.—This company, composed of Southern Pacific R. R. Co. parties, has been organized to build a branch of the Southern Pacific R. R., 250 miles long, in California from San Miguel, southeasterly through San Luis Obispo, Santa Barbara, Ventura and Los Angeles counties, connecting with the main line at Newhall. Capital stock, $10,000,000.

Chicago & Northwestern R. R.—The engineer corps has begun work at Onawa City, Ia., on the extension of the Maple River Branch from Mapleton. The distance is twenty-four miles, but the importance of the new road is that it will give the Northwestern the shortest line to Sioux City from Chicago, shortening its former route by more than 100 miles.

The Meigs Elevated Railroad.—On April 16th the train, consisting of engine, tender and passenger car, on the Meigs elevated road in Cambridge, was made up for the first time. It ran around the 50-feet curve and surmounted the 345-feet grade without difficulty. The legislative joint committee on street railways visited the road and witnessed a trip over the track: The members of the committee were much pleased with the exhibition.

Milwaukee & Northern R. R.—Work on the extension is actively begun. Grading has been commenced at both ends of the line, while considerable rock work has been accomplished. Mr. Woodard, chief engineer, has prepared plans for an extensive structure across the Menominee at Horse Race, three-quarters of a mile above Quinnesec, Mich. There will be 200 feet of trestle work 77 feet high. The bridge, with trestle, will be nearly 1,000 feet long.

Smith's Falls & Montreal Short Line R. R.—The plans for this road have all been completed and tenders have been called for to be in not later than May 14th. It is the intention of the Canadian Pacific R. R. Co. to proceed with the building of the road at once, and there will be work done at the Smith's Falls terminus this summer. Ties and rails are to be of unusual size. The curves and grades are very easy and every effort has been made to render it possible to attain a high rate of speed as well as to accommodate a large traffic.

A Mexican R. R.—A new contract has been entered into by the Mexican Government and the Tialmanalco Railway Co., of the State of Mexico. The contract provides that the company shall build its road at its own expense, and operate it for ninety-nine years from the station of La Compañia, on the Morelos Railway, to the town of Amecameca. If the road is not completed within two years, it shall incur forfeiture. For the space of fifteen years the railway company may import duty free all the material it may need for the road and telegraph line.

The Covington and Cincinnati Elevated Railroad Transfer and Bridge Co. has applied for the approval of the Secretary of War of plans submitted for the erection of a bridge between Covington and Cincinnati. The bridge will be of iron and steel, supported by five piers. It will be continuous, with two railroad tracks, and wagon and footway for pedestrians; will be erected at a cost of $3,000,000, and will be 53 feet higher than the high water mark of 1882. Mr. C. P. Huntington is said to be backing this project in the interest of his railroad system.

The Birmingham & Memphis R. R. Co. has been incorporated in Alabama. Capital stock, $2,500,000. Incorporators, George H. Nettleton and Wallace Pratt, Kansas City, Mo.; John A. Grant, New Orleans, La.; Enoch Ensien, Memphis, Tenn.; William A. Walker and Mitchell A. Porter, Birmingham, Ala. Capt. John A. Grant, chief engineer, says they will make the quickest possible job of the road, and calculates it will be completed to Memphis inside of eighteen months. Five locating parties will be put in the field, and contracts let as fast as the line is located.

Grand Trunk R. R.—The report of the Grand Trunk Railway Company deals at length with the position which the company now occupies. The total decrease in the net receipts for the half year was $550,000. This decline is attributed to the depression in trade, the war of rates and the loss of traffic caused by the small-pox epidemic in Montreal. The directors, however, consider the general finances of the company to be in a satisfactory condition, as the company is in a position to secure its full proportion of the general advantages confidently expected from the more peaceful arrangement now established among the American railway systems.

A Maine Railroad.—A line is proposed from Pittsfield or Skowhegan to Monson Junction. The former route would require twenty-eight miles, and the latter thirty-six miles of new road.

The Wheeling & Lake Erie R. R. has been sold at Cleveland, O., by Major W. F. Goodspeed, special master, on a decree of foreclosure issued by the United States Circuit Court, in the suit of the Farmers' Loan and Trust Company against the Wheeling & Lake Erie Railroad Company. There was only one bid—$505,000—which was made by George S. Forrest, Melville C. Day and Dan E. Garrison, of New York, as trustees of the re-organization committee.

Hannibal Bridge.—Engineers of the Wabash R. R. have been at Hannibal, Mo., and investigated what was necessary to do to rebuild the bridge across the river at that point. They say the work will be commenced at once. The draw-span will be constructed first and finished about the 1st of August. After this part is completed the rest of the work will proceed to a finish as soon as it can be done. The bridge is to be for the railroad and for the use of wagons as well. The present bridge is too light for the heavy trains as well as the large Wabash mogul engines which cross it daily.

Georgia Midland R. R.—The entire length of this road from Columbus, Ga., to Griffin will be sixty-five miles. Mr. P. P. Dickinson, of New York, the general contractor, has let sub-contracts for the grading as follows: E. M. Hooten, of Pike county, Ga., four miles; R. M. & J. M. Brooks, of Pike county, Ga., eight miles; F. M. & G. W. Clayton, of Clarksville, Ga., eight miles; the Chattahoochee Bridge Co., of Atlanta, twenty-six miles; Foley & Lumley, of Ohio, the tunnel through Pine mountain. The contractors are to begin work at once. There remain to be let four miles at the Columbus end and fifteen miles near Griffin, the work on which is very light.

Market Report of Engineering Materials.

New York May 6, 1886.

NOTE.—The following Market Report gives wholesale prices on the New York Market unless otherwise stated. It is intended as a general guide to the estimating engineer. We give it with this caution, that, as is well understood in business transactions, the amount of bill, distance from market centre and conditions of payment will have a material influence on the final paying prices.

IRON.

STRUCTURAL IRON.		
Angles	2.00c	@ 2.10c
" steel	2.35	@ 2.45
Tees	2.35	@ 2.40
Beams and channels, American	3.0	@
Tank Plates	2.13	@ 2.20
Shell Plates	2.4	@ 2.5
Steel plates, Tank	2.5	
WROUGHT-IRON PIPE. PITTSBURG.		
Butt welded, black.....Discount	42½	@ 45
" galvanized..... "	32½	@ 35
Lap welded black..... "	60	@ 62½
" galvanized..... "	42½	@ 45
Boiler tubes..... "	55	
RAILS.		
Steel (large lots at mill)	$35.00	@ $20.00
Old rails	19.00	@
Old rails, steel	22.00	@ 23.00
R. R. spikes	2.20c	@ 2.40c
R. R. splice-plates	1.70	@ 2.00
R. R. track bolts, square nuts	3.00	
Barb-wire fencing, galvanized	4.38	@ 4.45
" painted		4.00
Corrugated iron		
Nails		
Iron, per keg	2.10	@ 2.20
Steel do.	2.55	@ 2.60

METALS.

COPPER.		
Lake Superior	11.40	@ 11.50
Other Brands	10.00	@ 10.50
LEAD.		
Com. Domestic	4.70	@ 4.80
Lead Pipe	.06¾c.	
Tin-Lined Lead Pipe	.15	
Sheet Lead	.07¼	
ZINC.		
Sheet	$5.50	@ 5.70

BRICK.

Cargoes (afloat)		
Haverstraw.....per M.	8.50	@ 8.75
Fishkill		
Up-River	8.25	@ 8.50
Jerseys	7.50	@ 7.75
Long Island		
Pale	5.00	@
FRONTS.		
Croton, red	12.00	@ 15.00
" dark	12.00	@ 15.00
" brown	11.00	@ 14.00
Philadelphia pressed	24.00	@ 25.00
Trenton "	24.00	@ 25.00
Baltimore "	37.00	@ 41.00
Buff "	33.00	@ 35.00
Enameled English	65.00	@ 130.00
" American	85.00	@ 120.00
Fire brick	24.00	@ 85.00

CEMENT.

The following price current is made up entirely from quotations furnished us directly by the firms dealing in each brand; the prices are understood to be wholesale in New York, subject to such special rates as large quantities may warrant:

Alsen's Portland Cement Works	$2.50	@ $3.00
BAETJER & MEYERSTEIN:		
Hanover Port.and	2.60	@ 2.65
BELLONI & Co.:		
Hemmoor "Crown" brand		2.50
JAMES BRAND:		
K. B. & S	2.55	@ 3.00
BROOKS, SHOOBRIDGE & Co.	2.45	@ 2.60
HOWARD FLEMING:		
Gibbs' English Portland, 400 lbs.	2.65	@ 2.90
K. B. & S. "	2.75	@ 2.95
Stettiner, German	2.65	@ 2.85
Lagerdorfer, "	2.45	@ 2.75
Fleve, A 1, Belgian	2.35	@ 2.50
Roman	2.75	@ 3.00
Keene's Coarse	4.75	@ 5.50
" Fine	7.75	@ 8.50
" Superfine	8.50	@ 10.00
FISHER, ERSKINE W.:		
Stettin (German) Portland Cement	$2.40	@ 2.75
GABRIEL & SCHALL:		
Vorwohler "Lion"	2.65	@ 3.10
HUDSON RIVER CEMENT Co. Rosendale		1. 0
JOHNSON & WILSON:		
Saylor's American Portland	2.15	@ 2.40
LESLEY & TRINKLE, Philadelphia, Pa.:		
"Giant" Portland	2.20	@ 2.40
Improved "Union"	1.25	@ 1.50
Union	1.10	@ 1.20
MARCIAL & Co.:		
J. B. White & Bros. Coarse	4.50	@ 5.00
" Fine	8.00	@ 10.00
" Portland	2.45	@ 2.85
NEW YORK CEMENT Co.:		
Rosendale		1.20
N. Y. & ROSENDALE CEMENT Co.:		
Rosendale, "Bridge" brand		1.10
SINCLAIR & BAUSON:		
K. B. & S	2.35	@ 2.60
STANDARD CEMENT Co		
E. THIELE:		
Dyckerhoff	2.90	@ 3.25
UNITED STATES CEMENT Co.:		
Windsor	1.00	@ 1.10
Standard		1.15
Cald 's Portland	2.15	@ 2.40
UNION AKRON CEMENT Co.:		
Akron "Star" brand.		

ASPHALT.

ROCK.		
Prices range per ton	$15.00	@ 20.00
According to quantity or brand, and whether taken from vessel or store.		
PAVEMENT.		
Barber's Asphalt	$2.50	@ $3.50

LIME.

Rockland, common per bbl	1.00	
" finishing	1.20	
State, common	.90	
" finishing	1.10	
Kingston, ground	.95	@ 1.00
Add 25c. to above figures for yard rates.		

STONE.

Cargo rates at New York.

Amherst freestone, No. 1 per cub. ft.	0.95	@ 1.00
" " No. 2 "	0.75	@ 0.85
" " light drab "	0.80	@ 0.95
Berlin " in rough "	0.75	@ 1.00
Berea " " "		
Brown stone, Portland, Ct. "	1.00	@ 1.35
" Belleville, N. J. "	1.00	@ 1.35
Granite, rough	0.45	@ 1.25
Common building stone per load	2.00	@ 3.00
Base stone, from 2½ to 6 ft. lengths, per lin. ft.	0.40	@ 3.00

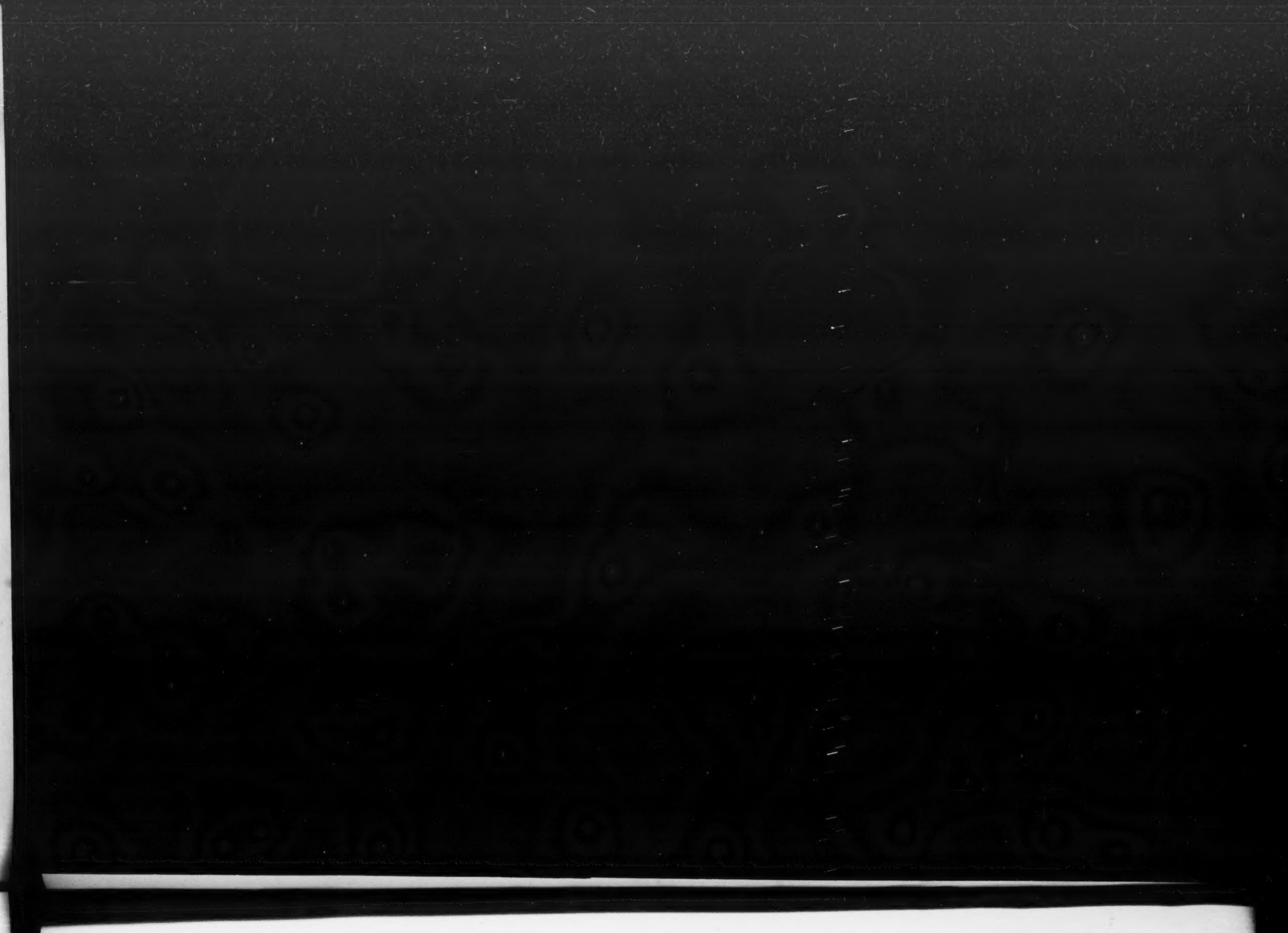
SLATE.

Purple roofing per square	6.00	@ 7.00
Green "	6.00	@ 7.00
Red "	15.00	
Black Penna. (at New York) "	4.50	@ 5.00

LUMBER.

Prices for yard delivery in New York.

PINE, Common box per M.	18.00	@ 20.00
" Choice "	65.00	@ 70.00
Tally plank, 1¼ in. 10 in. dres'd. each.	.44	@ .50
Tally boards, dressed com. "	.28	@ .30
SPRUCE, Boards dressed "	.25	@ .28
Plank, 1¼ in "	.28	@ .30
" 2 in. "	.38	@ .40
" 2 in. dressed "	.43	@ .45
Timber per M.	20.00	@ 22.00
HEMLOCK, Boards each.	.18	@ .20
Joist, 2½ × 4 to 4 × 6 in	.16	@ .44
OAK per M.	55.00	@ 65.00
CYPRESS 1, 1¼, 2 and 2½ in "	35.00	@ 40.00
YELLOW PINE, Girders "	25.00	@ 30.00
Dressed flooring "	28.00	@ 35.00
SHINGLES, Extra shaved pine, 16in. "		
" sawed 18 in. "	5.75	@ 6.00
LATH, Cargo rate "	2.15	@ 2.25

PAINT.

Lead, white, American dry per lb	.04¾	@ .06½
" " " in oil pure "	.07	@ .07½
" English, B. B. in oil "	.08¾	@ .08¾
" Red, American "	.05½	@ .06
Litharge "	.05	@ 05½
Venetian red, American "	.01	@ .01¼
Indian red "	.08	@ .10
Vermillion, American lead "	.10½	@ .11½
Paris green "	.15	@ .18
Umber, Amer. raw and powdered per lb.	.01¼	@ .01¾
Drop black, Amer. "	.07	@ .13
" " Eng. "	.11	@ .13
Chrome green "	.10	@ .25
Oxide zinc, American "	.03½	@ .03¾
" French "	.05½	@ .07½